AGRICULTURAL ENGINEERING

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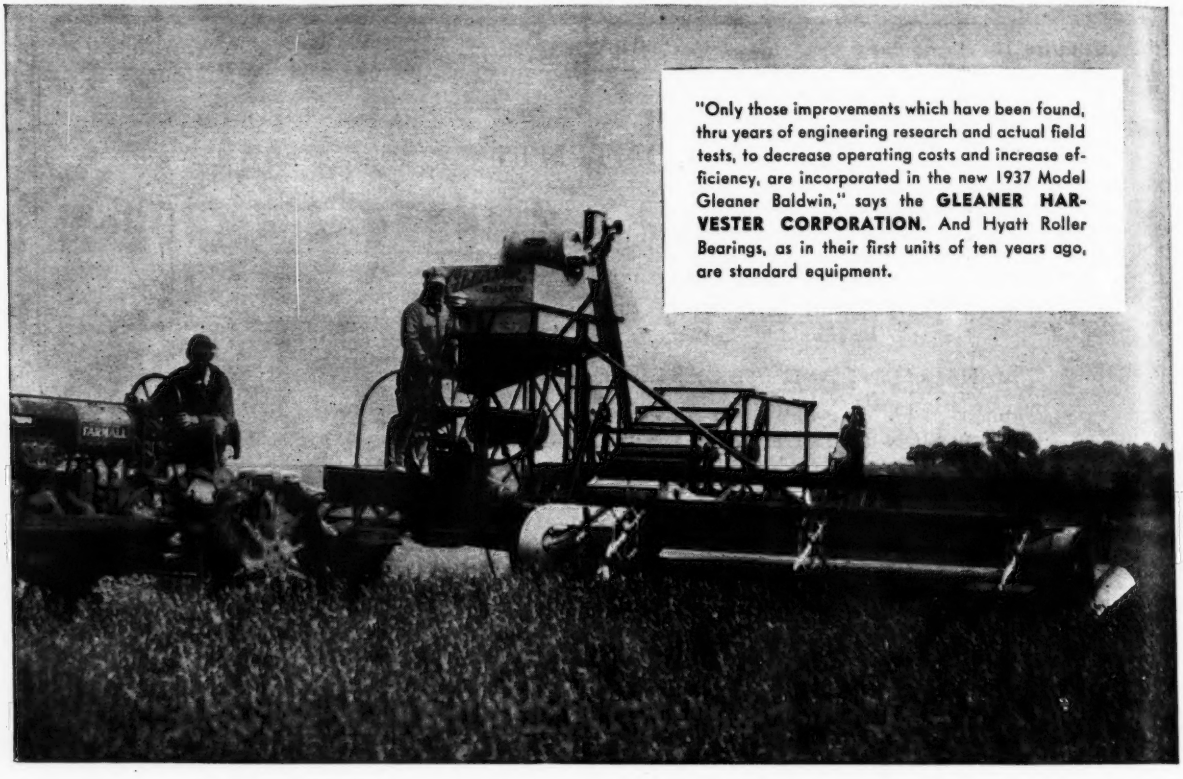
IT'S A TOUGH LIFE



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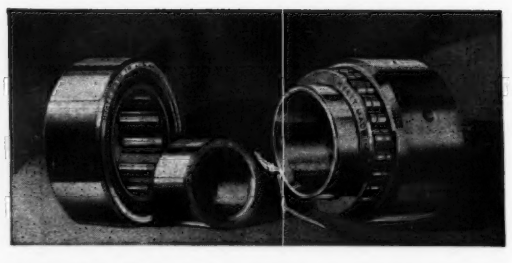

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AGRICULTURAL ENGINEERING

VOL 18, NO 7 EDITORIALS JULY 1937

Meetings and Membership

REGISTRATION figures of the recent annual meeting of the American Society of Agricultural Engineers at Urbana, Illinois, offer an interesting study. Of the 401 paid registrations, 260 were ASAE members. This amounts to 27.5 per cent of the Society's membership, a high percentage for any organization of comparable size and nature to draw to any one meeting.

The record-breaking factor in the attendance, however, was the 141 nonmembers registered, in addition to guests, 78 students, and other courtesy registrations. Of these 141, 12 had already indicated their interest with recent applications for membership. Renewed interest, improved circumstances, or both, presumably accounted for the presence of 12 former members of the Society. Prospective member files of the Society show that 22 of those remaining have recently been invited to apply for membership. Having taken the opportunity to see the Society in action, they should now be in a position to definitely decide whether or not they would be justified in applying for membership.

What of the remaining 95? They are men in agricultural engineering or related work, not in the current prospective member file of the Society, but interested enough to go to Urbana from Oregon, Alabama, South Dakota, Oklahoma, Minnesota, Pennsylvania, New York, Connecticut, the District of Columbia, and other points, to attend the meeting.

It is apparent that many members did excellent work in inviting interested nonmembers to attend. In some cases they actually brought nonmembers along with them. Registration of these 95 men, whose names had not even been submitted to the Society headquarters as being interested in agricultural engineering, indicates further that membership opportunities are being overlooked. Some members are apparently having contacts with nonmembers who are in agricultural engineering work, without realizing that they are logical candidates for membership; without telling them about the Society and inviting them to apply for membership; and without giving the Society headquarters a chance to interest them in the Society.

The ASAE is not interested in mere numerical strength. It is interested in becoming as truly and completely representative of all men engaged in agricultural engineering work as may be possible. The field is continually absorbing new men, not only from agricultural engineering courses, but from other branches of engineering, science, and technical and commercial interest. In the past year the Society enjoyed a 20 per cent increase in membership. To continue to effectively represent the agricultural engineering branch of the engineering profession it needs, in the immediate future, to continue growing at about the same rate. It can if present members do not overlook the logical prospects for membership with whom they come in contact.

Editorial Policy

A PERFECTLY logical and desirable question has arisen in one of the ASAE committees as to whether the valuable space occupied by editorials in AGRICULTURAL ENGINEERING is being used to best advantage. Our contribution toward a solution of this problem is the following consideration of editorial policy.

Editorials, being short essays on timely subjects, may be written to give information, arouse interest, stimulate thought or action, or for a number of other purposes. We have felt that editorials in AGRICULTURAL ENGINEERING would be of greatest value if they called attention to various viewpoints, pictured features of the agricultural engineering field from the editors' point of observation, and otherwise raised stimulating questions for thought by ASAE members and other readers, along lines which might be profitable to them, individually and as a group, and to the progress of their work. Moreover, these pages are open, to the limit of space available, to any and all members desiring to express editorially their views on agricultural engineering questions.

We have not thought it desirable to waste these pages on dead issues or widely accepted truths. Nor have we found it desirable to attempt to say the last word on controversial questions. When we have erred in this direction, we have been promptly and properly called to account.

We have not thought it possible or desirable to arrive at a concensus of opinions of ASAE members on controversial questions, and we have not attempted to dignify our editorials with the weight of Society approval.

Whether or not the Society should take sides on controversial matters, or declare its viewpoint fixed on any but the broad general principles and purposes defined in its constitution, is a question for the whole organization to decide. When the Society finds it desirable and proper to present a unified front, and to express its views on any particular question, in resolutions or otherwise, editorials might assist in supporting and spreading knowledge of its position. But such opportunities are too rare to call for definite space in every issue of AGRICULTURAL ENGINEERING.

The editorial policy of the Journal is, of course, subject to the pleasure of its owners, the corporate members of the American Society of Agricultural Engineers. They can help materially to make it what they want by letting the editors know their wishes as to the space to be given to editorials, subject matter to be covered, form of presentation to be used, and any other suggestions for improvement. Until some such suggestions are received we can only continue the present policy and ask that the editorials be read as they are intended, merely as thought-provoking ideas gathered from here and there, and presented for what they may be worth.

Engineering Analysis of Agriculture

WITH characteristic clarity Dr. E. A. White has revived the question of an engineering analysis of agriculture, which various agricultural engineers have suggested and discussed at intervals during the past decade or two.

Engineers are supposed to be able to intelligently analyze facts, conditions, and situations in their field. Agriculture is the field of agricultural engineers.

Dr. White does not suggest that agriculture be analyzed completely and finally, as a static industry, in one momentous study. He does suggest that the changes taking place in agriculture be looked at by agricultural engineers in terms of power, labor, operating equipment, and organization for efficient farm production and farm life.

Agriculture is too big, too complex, and changing too rapidly ever to be harnessed, for easy comprehension, with words, tables, and graphs between the covers of a report, no matter how voluminous. Dr. White's implication, as we see it, is that agricultural engineers might well take a more analytical attitude toward agriculture, as a matter of course, in their daily work. He cites needed engineering knowledge of agriculture which has not yet been developed. A more analytical attitude toward agriculture on the part of all agricultural engineers should emphasize the importance of such data, and lead to its development.

The direction of agricultural engineering work is no mere happenstance. It is chosen or assigned, and supported, from an ocean of unsolved problems, for its relative or immediate importance as seen by administrators, engineering or otherwise. Dr. White has raised unanswered questions of great importance in the direction of specific work, both commercial and public service. They are questions to be answered by engineering analysis of agriculture. They will be answered, not by any one major endowed analysis of agriculture, but by an analytical attitude on the part of all agricultural engineers which enables them to direct their own work most intelligently and to help those administrators who are not agricultural engineers to decide on the relative importance of work to be supported.

For Dr. White's views on the subject, first hand, the reader is referred to his inspiring paper on "Electrification of American Agriculture," published elsewhere in this issue.

Engineering the Production of Specific Crops

CONSIDERABLE attention has been given to engineering the production and handling of certain crops, including corn, cotton, fruits, garden and greenhouse crops, the small grains, hay, potatoes, sugar beets, and sweet potatoes. Some other crops have received a lesser amount of engineering attention.

Most of this work has been in the logical and laudable piecemeal solution of specific problems occurring anywhere along the production line, from propagation to storage and preservation. Seedbed and rootbed preparation, planting, fertilizer placement, cultivation, irrigation, disease control, insect pest control, weed control, harvesting, cleaning, preliminary processing, and preservation present challenging engineering problems. They involve extensive power applications, intricate and varied mechanical operations, accurately performed functions, and precise control over environmental conditions, based on biological requirements.

But engineering the production of a specific crop involves more than engineering the specific operations required. It calls for integrating the engineered power sources, operating equipment, and operations into an efficient, low-cost, smooth-running production program, with a high use factor for equipment, and minimized seasonal loads. It calls not only for organizing and integrating the operations of the one crop, but also for fitting the production program of that crop into the production programs of specific farms involving other crops and animal industries.

If agricultural engineering is to be, in fact, the engineering of agricultural biology, as suggested by C. O. Reed, the engineering of specific crops and classes of crops, representing divisions within the field, would seem a logical step in the indicated direction. Only a small start has been made, on only a few crops. Here is work for agricultural engineers far into the future.

Flax and Hemp for Paper

CURRENT interest of industry in flax and hemp as domestic sources of fiber for fine papers has brought to light some incidental agricultural engineering problems.

When these crops are produced for fiber, cultivating and harvesting operations differ materially from those used in producing seed. In a paper before the third national farm chemurgic conference at Dearborn, Michigan, Harry H. Straus of the Champagne Paper Company pictured the development as it stands today.

Flax and hemp have been selected from a wide variety of plants as producing the best quality of fiber for fine papers. A simple mechanical method of decortication has been developed. Chemists have evolved a method for converting the fiber into the required quality of paper pulp. The whole process has been developed and tested far enough to demonstrate its essential feasibility.

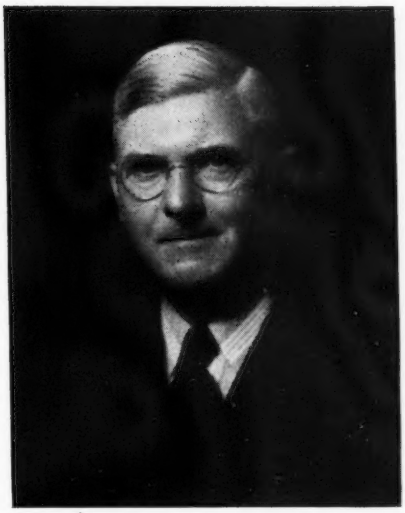
Some of the related agricultural engineering problems involve refinements in preparation of the seedbed, methods of seeding, harvesting equipment, weed control, preliminary processing on the farm, and lowering the costs of all the farm operations involved. Existing equipment needs to be adapted and new equipment developed. There is a possibility of field decortication, or of decortication in farm or community mills, to reduce the handling cost on the 80 per cent of stalk weight not used in paper making.

As to the extent of demand of the light-weight paper industry for hemp and flax fibers, Mr. Straus estimates it at 15,000 to 20,000 tons per year. This would require 100,000 acres or more in these crops. While this is nothing stupendous, it is a sizeable opportunity for new agricultural production not competing with existing farm crops. It also offers a splendid opportunity for service to the agricultural engineers who can solve some of the problems indicated.

Thermometers and Thermostats

By R. U. Blasingame

THE program for this meeting is replete with papers relating to the technical aspects of agricultural engineering. This has been true of practically all our programs during the thirty years that this Society has been in existence. The material presented at our meetings has established agricultural engineering as a profession and developed a remarkable literature pertaining to the utilization of the forces and materials of nature for the benefit of mankind.



R. U. BLASINGAME

My intention in this address is to discuss a subject which has received little attention on our programs, yet it is one in which our profession should be vitally concerned. I refer to the production of a higher type of agricultural engineer by giving more attention to those factors which Dr. Friley called "human engineering" in his inaugural address when he became president of Iowa State College.

What is meant by "human engineering" and what relation has it to agricultural engineering? An explanation of why I chose "Thermometers and Thermostats" as the title of this paper may help to make this clear. Thermometers indicate existing conditions. They have no ability to alter these conditions. They endure without making any effort to cure. Thermostats, on the other hand, change unfavorable conditions to favorable. The world needs more human thermostats. The agricultural engineering profession would be materially advanced if we had more of them in our membership.

We older members, mostly of the thermometer variety, cannot very well be transformed into thermostats at this late date. However, we have an opportunity and duty in developing a higher percentage of thermostatic engineers from the youths entering our profession. This can be done by more careful selection, and by seeking to develop common sense and wisdom which are not commonly discussed in the classroom or included in the curriculum, but are of vital importance to a successful career.

The proper place to start to improve the quality of future agricultural engineers is in the choice of raw material. Today men can be tested and selected like steel or cement. It is now possible to know with considerable definiteness whether or not we are starting with properly qualified individuals—whether they are thermometers or thermostats. Uniform and proven facilities already are in practical use in industrial, commercial, and academic circles which offer great possibilities in this direction but of which we have not yet taken full advantage in the selection and development of agricultural engineers. I am not referring to the elementary although highly useful I.Q. tests that are commonly given to most freshmen, but to a more comprehensive technique designed to classify people according to their natural abilities and aptitudes. We are following practically the same methods of selecting engineering students and placing them in industrial, educational, or research work as were followed a quarter of a century ago.

It is logical that we should select young agricultural engineers as carefully and accurately as Connie Mack selects baseball players or as athletic coaches select the material for their teams. They know they cannot succeed with men of mediocre caliber and character. The men who are picked are of the highest grade available. Candidates having even minor shortcomings in any one of many desirable characteristics are quickly eliminated. They must not only have outstanding ability, but also courage to perform under adversity. Thermometer types are not acceptable in those fields; thermostats are required. The profession of agricultural engineering should not be satisfied with anything short of this standard.

Granting that there is a limited number of available young men from which we can obtain agricultural engineers of the future, and granting, also, that we cannot judge by their records and performance to the extent the coach can, nevertheless I submit that the manner in which we have chosen in the past is susceptible to great improvement if we use the methods which are already developed. It seems highly probable that in the near future agricultural engineering graduates, before being employed by many of our major institutions, will be subjected to such a test. We should be certain that we are training engineers who will measure up to the requirements.

The members of this Society who are connected with industry should not get the idea that this is a matter which concerns only the men engaged in teaching agricultural engineering. A college course is only the beginning of an agricultural engineer's training—industry must take the graduates and continue their education. Industry should be, and I believe is, just as much interested in the quality of young engineers as are those of us who are responsible for training them.

Let us consider for a moment the kinds of work in which agricultural engineering graduates most frequently engage. In the case of industrial concerns, this may be designing, selling, or servicing. Advertising and extension service might be included under selling. Public service work includes teaching, research, or extension. Some will find employment in managing farms, either for themselves or for others.

In all these activities, a knowledge of the fundamentals of agricultural engineering is essential. But a good designer is not necessarily a good salesman, nor is a first-class sales-

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Annual address of the President of the American Society of Agricultural Engineers before the annual meeting of the Society at the University of Illinois, Urbana, Ill., June 22, 1937.

Author: Professor of agricultural engineering (head of the department), The Pennsylvania State College. Mem. ASAE. (President ASAE, 1936-37).

man the type of man best suited for service work. A good research engineer does not always make a good instructor and *vice versa*. Not only is it desirable to have engineers of higher grade, but also it is essential that square and round pegs be placed in their respective holes. As agricultural engineers, we would not think of using low carbon steel where high carbon would be more suitable. In heat-treating steel to make it of maximum value for the particular purpose for which it is to be used, we are governed entirely by its characteristics. In a similar manner I believe we should adapt the treatment of the human material from which we produce agricultural engineers to serve different purposes. We should analyze and test the raw material even more carefully than we would analyze and test the steel for some important use. We should know what kind of treatment will bring out the best qualities in each piece. When the treating process is completed, we should be careful to locate each piece in a place where it will be most useful.

Industrial concerns already are beginning to use the psychologists in selecting certain employees. They have learned that it is expensive as well as unsatisfactory to place thermometers where the conditions require thermostats. Applied psychology offers a means of determining with a high degree of accuracy whether a candidate for a particular job is likely to prove satisfactory. We should take advantage of all available help in the selection of the human material from which we expect to develop agricultural engineers. We should lend every possible assistance to the psychologists in applying and perfecting the technique which they have devised for making such selections. The psychologists say that aptitude for the engineering profession has proved to be one which can be most accurately determined by psychological methods.

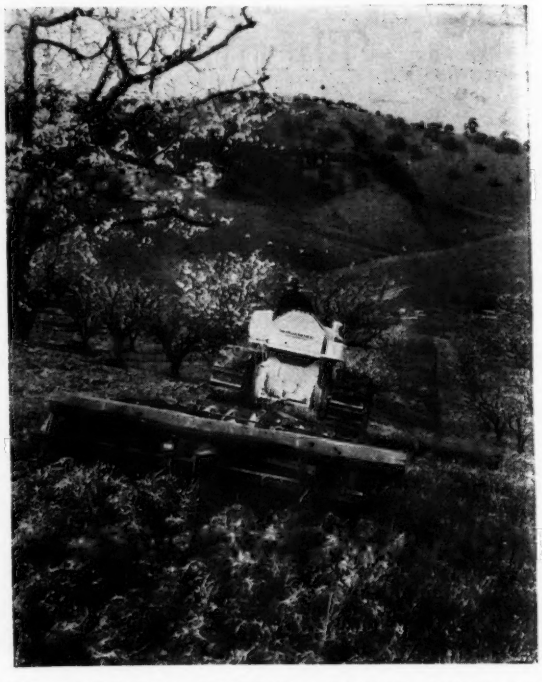
For years, agricultural engineers have cooperated with agronomists, soil chemists, plant pathologists, and others in agricultural science. This cooperation has been mutually advantageous. I believe it is now time for us to cooperate with another group, the psychologists. Judging by the results they are achieving in other directions, they can be of real help to us.

I realize that merely being able to tell how well adapted for the profession each individual candidate is will not solve the problem. But knowledge of this kind would be a long step in the right direction. Nor do I mean to say that the technique developed thus far for use in determining in advance about what we may expect from different individuals in various types of scientific work is perfect. It may not even be satisfactory at present. But I believe sufficient progress has been made to warrant giving it a thorough trial.

I realize, too, that probably we shall always have to accept some students because they want to take agricultural engineering, or because their parents want them to take it, even though a test such as I have referred to indicates that they cannot hope to be more than thermometers. But such tests would certainly tend to eliminate some who merely leaned toward agricultural engineering. It seems reasonable to believe that there would be many cases in which the tests would show that certain students who were doubtful about entering agricultural engineering had exceptional ability along this line, and would therefore be influenced to take it.

In a recent conference with a psychologist, he listed the characteristics which he considers essential for a successful agricultural engineer. These were:

1 Intelligence, or the mental ability to select and apply the elements needed to arrive at the correct answer of a problem.



SOME AGRICULTURAL ENGINEERING GRADUATES MANAGE FARM OPERATIONS. IT IS IMPORTANT THAT THE SQUARE AND ROUND PEGS FIND CORRESPONDING HOLES

2 The ability to solve mathematical problems.

3 Interest, or drive, to motivate his purpose to carry to a successful end any enterprise even in the face of difficulty.

4 The type of personality represented by sociability, aggressiveness, and self-confidence.

5 Mechanical aptitude which will aid him to think through and correctly design a plan.

6 Mechanical skill to execute his own designs or the designs of others.

7 That rare quality of social intelligence necessary to get along with people.

It is interesting to compare this list of qualifications with the results of a study by Dr. C. R. Mann, of the Carnegie Foundation. He tabulated over 1500 replies from practicing engineers to whom he addressed the question: "What are the essential qualities of a successful engineer?" Averaging the replies, he found they were:

Character, 41 per cent
Judgment, 17.5 per cent
Efficiency, 14.5 per cent
Understanding of human nature, 14 per cent
Technical knowledge, 13 per cent.

These engineers considered that 87 per cent of ability to produce results was based on qualities developed outside of the ordinary university classroom training. Their major difficulties were largely life difficulties, not engineering difficulties. I believe that the analysis of this psychologist and the opinions of these 1500 engineers, which are in close agreement, are highly significant and deserve our careful consideration.

This brings us to the second part of the problem of obtaining a higher percentage of engineers of thermostatic abilities. I am not at all concerned that the student may not receive sufficient technical knowledge of agricultural

engineering. I believe the usual curriculum is adequate in this respect. But the problem of developing common sense and wisdom is far more difficult than the attainment of technical knowledge. Knowledge is defined as that which is gained and preserved by knowing; enlightenment; learning; scholarship. Wisdom is the ability to judge soundly and deal sagaciously with facts, especially as they relate to life and conduct. It is the capacity to make correct application of knowledge. It is the perception of the best ends and the best means. It is discernment, judgment, discretion, sagacity.

Wisdom and common sense are what the psychologist meant when he said, "That rare quality of social intelligence necessary to get along with people." Developing such a quality is not easy, which is probably the chief reason we have not made more progress along this line. But if we have sufficient thermostatic capacity we should be able to develop plans which will achieve much better results in the future than in the past. Some of us have made the mistake of allowing the student to believe that if he attained technical knowledge, his success would be assured. We know now that this is not true. This does not mean that high scholarship should be discouraged. The least that can be expected of a student is that he will creditably pass all of his college courses. We owe it to our students to tell them in no uncertain terms that it is more important for them to develop those characteristics which are essential to success in dealing with people than in dealing solely with mechanical skills. These matters can best be brought to the student's consideration when he is in individual conference with his instructors. It is essential that more time be given to such conferences. Some of you are thinking there is not time to do much along this line. In the past it has doubtless been the case. But if, by improved methods of selection, we obtain a group of students with higher capacity, there will be more time to devote to human engineering, which will transform some embryo thermometers into effective thermostats.

Means must be provided for extra curricula activities of the type which require the student's cooperation with his fellows. One of the most effective ways is through the student branches of the American Society of Agricultural Engineers. I especially wish to express appreciation of the interest which the Farm Equipment Institute has taken in encouraging student branch activities. The meetings of these branches are very helpful by teaching the student to listen to and respect the opinions of others, and to exchange ideas. Activities which require considerable cooperation, planning, financing, and labor are of even greater benefit. He learns by actual experience the importance of such qualities as dependability, honesty, loyalty, efficiency, judgment, courage, cheerfulness, patient persistence, willingness, kindness, self-restraint, and general common sense. For these reasons, I believe we would be justified in encouraging the students to increase student branch activities even, if necessary, to the exclusion of some minor technical courses.

I believe that every member of the staff of the agricultural engineering department should be required to devote such time to student branch activities as will assure successful organizations. Students cannot be expected to devote their time to such extra curricula activities unless the staff sets the example of cooperation and organization outside of their routine duties.

The objectives can be brought home to the students if industrial representatives are invited to speak to them on the subject: "What Industry Expects of Young Agricultural Engineers Entering Its Employ." Most personnel directors of leading industrial concerns are willing to accept such assignments, and they are very helpful.

I see no reason why the student should not be made to stand a private oral examination in these matters, from time to time, just as he is required to pass written examinations on technical subjects. If he shows any indication of unwillingness to cooperate with others, it should be considered just as serious a defect as though he had failed a course in his academic work. Such a situation should challenge his faculty advisor to exercise his best efforts as a human engineer to overcome this handicap.

The Farm Equipment Institute and the American Society of Agricultural Engineers are giving consideration to inaugurating a summer school in industry. The agricultural equipment industry will offer this course to a selected group of juniors for the purpose of acquainting them with the cooperation that exists among the various departments of each industry. This cooperation involves the human element that I am stressing.

The purpose of this paper is to stress the importance of paying more attention to the human element in training men. Without minimizing the importance of technical training, let us give this new factor special emphasis. We should be concerned about producing thermostats rather than thermometers.

Windmills Protect Pipelines from Corrosion

THE eerie squeak of the windmill, once annihilated by gasoline power, has returned to haunt the home of its successor. Windmills are being used to protect vast pipe line networks from corrosion.

Thousands of miles of underground steel pipe carry crude oil, stabilized crude, refined products and gas. Conditions are ideal for corrosion, with heavy leakage and maintenance costs, for when steel is thus buried underground small electrical circuits are set up, currents on which the metal floats away. Technically it is electrolytic corrosion, with the steel pipe the anode from which iron ions go off into the soil. One ampere of current will carry away 20 pounds of steel per year, and as this loss usually comes from small local areas, the corrosion problem is serious.

By the simple procedure of reversing the current by impressing a small voltage from an outside course this electrolytic corrosion is stopped, the pipe becomes the receiving end—the cathode—and is protected by a layer of hydrogen formed at that point.

The practice of this new method may be applicable to other situations where steel is buried in moist earth. A hole is dug near the pipe line and scrap iron dumped in. Sometimes rock salt is added to make the ground more conducting. The pile of scrap iron is connected with the positive pole of a source of low-voltage direct current, and the negative pole is connected with the pipe line, usually in a number of scattered places. Through the circuit thus formed, current flows from the positive pole of the source of electricity through a copper cable to the scrap iron, the anode, which corrodes rapidly but is of negligible value. The current then flows through the earth, the ions being carried by the moisture in the soil, to the pipe line, now the cathode, and a protective film of hydrogen forms on it. The current then returns to the source by another copper cable.

Any source of electric power may be used for this "cathodic protection," but the commonest are probably small low-voltage generators driven by windmills. In the pipe line country of Texas and adjoining states the winds are steady and reliable, and the almost obsolete windmill again becomes a familiar mark on the landscape.—Industrial Bulletin of Arthur D. Little, Inc.

A Method for Finding Terrace Cross Sections

By Harold W. LeMert and Austin W. Zingg

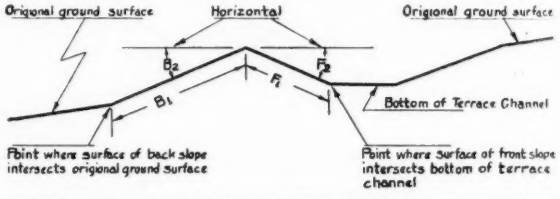
HERETOFORE there has been no practical method whereby one terrace could be easily and quickly compared with another. Of course all engineers have known that a comparison is possible by the orthodox cross-sectional method, but the trouble entailed in securing and plotting the data and in calculating the area has restricted the use of this method. Unfortunately, too, the method is one that only professional engineers can use.

This article describes a quick, practical method for measuring terrace ridge and channel cross sections with a degree of accuracy sufficient for all practical field purposes. The method involves a procedure that any person interested in this work can understand.

Described from a station on the high point of the ridge, that side of the berm facing the receding slope of the field will be designated as the "back slope", and its length as B_1 (see accompanying drawing). This length is the distance from the center of the ridge to a point where the back slope intersects the original ground surface, or, if earth has been moved from the lower side, to the lowest point on the exposed soil profile. The angle between the back slope and the horizontal will be called B_2. The side of the ridge facing the terrace channel will be referred to as the "front slope," and its length as F_1. This length will be measured from the center of the ridge to that point where the front slope intersects the bottom of the channel. F_2 designates the angle of the front slope with respect to the horizontal. B_1 and F_1 are measured in units of feet and B_2 and F_2 in units of per cent.

After measuring B_1, B_2, F_1, and F_2 in suitable units, the next step is to refer to the accompanying table of cross-sectional areas. In using this table, take the values for the back slope that most nearly correspond to the measurements obtained and interpolate, if necessary, in column F_1 and in the four that give the area of the cross section.

For example, measuring slope units in per cent and length units in feet, suppose B_1 equals 19 ft, B_2 equals 13 per cent, F_1 equals 8 ft, and F_2 equals 16 per cent. In the table of cross-sectional areas only the values 10, 15, 20, and 25 are given in column B_2. Of these values use the one that is nearest 13, namely, 15. In the column B_1 the only values shown are 8, 12, 16, and 20. The measurement of B_1 that has been selected is 19. *(Continued on page 300)*



CROSS SECTION OF A TERRACE SHOWING POINTS OF MEASUREMENT

Authors: Respectively, associate agricultural engineer (Mem. ASAE), and assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture.

AREAS OF TERRACE CROSS SECTIONS IN SQUARE FEET

B_2, per cent	B_1, ft	F_1, ft	Area of cross section: F_2, 10 per cent	F_2, 15 per cent	F_2, 20 per cent	F_2, 25 per cent
10	8	5	4.0	4.8	5.3	6.9
10	8	7	5.6	6.9	8.5	9.6
10	8	9	6.5	8.2	10.0	11.6
10	8	11	8.8	10.8	12.8	15.0
10	12	5	5.6	9.4	8.8	10.2
10	12	7	7.4	10.5	12.5	14.4
10	12	9	11.0	13.5	15.9	18.3
10	12	11	13.5	15.4	18.6	22.6
10	16	5	8.1	9.9	12.7	13.7
10	16	7	11.2	13.9	16.6	16.3
10	16	9	14.7	18.2	21.2	24.6
10	16	11	17.5	21.7	26.0	30.2
10	20	5	8.7	12.4	14.8	16.0
10	20	7	13.7	17.2	20.4	23.7
10	20	9	18.3	22.6	26.5	30.7
10	20	11	22.0	27.2	32.5	37.3
15	8	5	5.0	5.1	6.8	10.9
15	8	7	6.8	8.3	9.6	11.0
15	8	9	9.1	10.7	12.3	13.2
15	8	11	11.3	12.8	14.8	17.0
15	12	5	8.5	8.8	10.3	11.7
15	12	7	9.5	11.5	14.3	16.1
15	12	9	13.5	16.2	18.6	20.5
15	12	11	16.7	19.9	22.6	25.9
15	16	5	9.9	11.8	13.7	15.5
15	16	7	13.9	16.7	19.6	22.2
15	16	9	18.1	21.4	24.9	27.8
15	16	11	22.0	26.3	30.3	34.1
15	20	5	12.4	14.5	17.3	19.4
15	20	7	17.4	20.9	24.4	27.5
15	20	9	22.0	26.9	31.3	35.2
15	20	11	27.7	32.9	38.0	43.0

B_2, per cent	B_1, ft	F_1, ft	Area of cross section: F_2, 10 per cent	F_2, 15 per cent	F_2, 20 per cent	F_2, 25 per cent
20	8	5	5.8	6.6	7.2	8.3
20	8	7	8.2	9.2	10.8	12.1
20	8	9	10.6	12.3	13.7	15.3
20	8	11	13.0	14.0	16.7	18.7
20	12	5	8.8	10.0	10.8	11.8
20	12	7	12.2	14.3	16.3	18.4
20	12	9	16.0	17.7	21.1	23.4
20	12	11	19.4	22.6	25.6	28.5
20	16	5	12.0	13.6	15.5	17.1
20	16	7	16.3	19.0	21.7	24.2
20	16	9	21.4	24.8	27.9	31.4
20	16	11	26.0	30.4	34.4	38.3
20	20	5	15.5	17.7	19.3	21.7
20	20	7	20.4	23.7	27.0	30.0
20	20	9	25.3	29.5	33.5	38.0
20	20	11	32.5	37.7	42.6	47.3
25	8	5	6.8	7.6	8.6	9.4
25	8	7	9.5	10.9	12.2	13.5
25	8	9	12.6	14.1	15.6	17.1
25	8	11	15.1	16.8	19.0	20.2
25	12	5	10.2	11.5	13.1	14.2
25	12	7	14.2	16.3	18.2	19.5
25	12	9	20.6	21.1	23.8	26.0
25	12	11	22.6	25.7	28.6	31.5
25	16	5	13.5	15.5	17.4	19.0
25	16	7	18.7	20.7	24.4	26.6
25	16	9	25.1	28.2	31.4	34.5
25	16	11	29.5	23.7	37.9	41.9
25	20	5	16.9	19.3	21.7	24.0
25	20	7	23.9	27.1	30.4	33.6
25	20	9	31.0	35.3	38.9	42.0
25	20	11	37.9	42.9	47.6	52.4

Management and Use of Agricultural Lands

With Special Reference to Erosion Control

By Noble Clark

WE LIVE in an era of science and invention, and these twin servants and wonder workers have done as much for agriculture as they have for any industry or profession.

It is the mechanization of farming that now enables 20 per cent of our national population to produce all the food and fiber needed by our people, and has released the other 80 per cent to work in mines and factories, in transportation, merchandising, and the professions. These 80 per cent produce the goods and services which permit Americans to have the highest standard of living ever enjoyed by any people in the world's history. This attainment would not have been possible if agriculture had still to be carried on by the old methods our grandfathers used. In Washington's day it took the labor of 90 per cent of the population to raise the needed farm products for the nation. We today would have much the same standard of living as our grandfathers if it were not for the spectacular aid which science and invention have given to farming.

The disquieting fact remains, however, that with all of our agricultural science, which has increased the efficiency of individual farmers, we have barely compensated for a rapidly decreasing soil productivity. Erosion losses and depleted supplies of mineral plant food and organic matter have kept average acre yields to about what they were 50 years ago. Deterioration of our capital assets has proceeded about as fast as we have improved our farm operation methods. We now face the realization that to permit these capital losses to continue is to jeopardize the economic future of America. Agriculture is truly the foundation of manufacturing and commerce, and a policy that permits this foundation to crumble away can only result in the impoverishment of all industry and the decadence of our American standard of living.

I submit that the biggest single task before the American people is to solve the problem of preserving the land resources of the nation while they are being lived upon and used. We cannot, if we would, turn our six and one-half million farms back to forests and grass in a naive effort to return them to the state they were in when white men took them from the Indians. We cannot support 130 million people on an economy of grass and trees. Just as certainly we cannot permit continuation of the exploitive soil management practices which have characterized our American farming methods.

Soil erosion control is a big job physically because it involves hundreds of millions of acres and the activities of 30 million farm people. It is just as big when viewed from the standpoint of the social and economic issues at stake. All of you will agree that to date neither our thinking nor our field programs have matched the size of the task that needs to be accomplished.

Soil erosion control programs have created much controversy, and have been frequently criticized for lack of coordination and integration, and for inadequacy. This is not so surprising when we remember certain inherent weaknesses and complications, enumerated as follows:

1 By its very nature erosion control is not capable of solution by a single scientific discipline. The engineers cannot do it alone, although sometimes the public has been in doubt as to whether all engineers recognized this. The same can be said for soils specialists, agronomists, foresters, farm management men, and others. Experience has now demonstrated that an erosion control program worthy of the name requires close cooperation and integration of effort on the part of workers in at least a half dozen agricultural fields. But it is always hard to secure efficiency in an undertaking in which responsibility for planning, and authority for action, are diffused among several independent groups.

2 Erosion control is neither solely a matter concerning private landowners, nor solely a problem of public rights and responsibilities. It would be much simpler if it were. Here in the United States we are committed to a policy of private ownership of agricultural land. We cannot begin too soon to work out ways of protecting public interests in the management of these private lands.

3 The costs for erosion control are largely immediate, but the benefits extend over a long period of time; some of them are very remote. Uncle Joe Cannon is reported to have asked, "What has posterity ever done for us?" Weighing present costs, borne by the present generation, against benefits to be enjoyed by our grandchildren, constitutes a difficult decision for individuals and governmental agencies to make. This same conflict of private and public interests long delayed the United States in working out an entirely satisfactory forestry policy.

4 Because erosion threatens so much loss and destruction to the nation, and because the public generally tends to be rather apathetic and unresponsive, there is a strong tendency for those of us engaged in erosion control work to use up a good deal of our energy in exhortation, and in attempts at selling the public the need for our program rather than focusing our attention closely to the task of actually controlling erosion. The truth of the matter is that the best way to secure public support for a program is to do a job so efficiently that even the skeptics have to admit you have earned the support.

In our research projects dealing with erosion control it seems to me we particularly need more emphasis on the *how* instead of the *why*. Can we not assume that erosion needs to be controlled, and devote our imagination and effort to the challenge of finding how it can be controlled more effectively and more economically?

Erosion research can be divided into three natural categories:

1 *A measurement of the amount and character of soil and water losses from different soil types, different crops, etc.* This type of research was important for propaganda purposes a decade ago, but it is much less necessary now. With the meager and wholly inadequate funds available for erosion research, we should no longer be spending such a large percentage of our research allotments for this type of project. I am not condemning what has been done in the past, nor am I recommending any policy of wholesale abandonment. I am simply insisting that the new day demands a new and different emphasis in our research objectives.

2 *Attempts to evaluate the effectiveness of present*

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Author: Assistant director, Wisconsin Agricultural Experiment Station.

methods of erosion control, and to evolve new and better methods. We need much more research of this character. The men in the field actually carrying out the studies should be the most able, and the best paid, men in the whole soil erosion program. The future success of erosion control efforts is more dependent on this research than on any other single factor. The field program is hopelessly handicapped until the federal bureaus find a way of paying a scientist on some other basis than the number of persons he has working under him. A good research man, maybe working all alone, can often do more for the erosion program than a supervisor in the operations division sending out mimeographed orders to an army of underlings. A good soldier in research can often render as important service as a general in the operations division. Administrators have an essential place in any program. Far be it from me to deny this because I am one myself. But it is perfectly absurd to have a salary scale that draws nearly all the successful men out of research and into operations, or so-called supervision. Any large commercial organization would go on the rocks in a hurry if it followed such a policy.

Continuing to spend millions in the construction of terraces, dams, and other erosion control structures, without making careful measurement of the effectiveness of these structures in the actual handling of water and soil, is a policy no one will defend. So far as I know, however, this has been pretty largely the policy that has been followed. We all know what would happen if General Motors spent all its energies designing and building automobiles and trucks and never tested them out to see how they stood up in hard use.

When this evaluation study of erosion control structures is made, and I know it must be made soon, I have two suggestions to offer:

Make the measurements in terms of how the water and soil react to the structures, and do not spend much time or money surveying how the engineers or experts react. I do not have much confidence in a program of sending a committee of experts into the field to inspect and to evaluate control methods. Our need is not for more opinion, but for more exact data as to how the methods and structures actually function when exposed to heavy downpours of rain.

Why not use some of the capable engineers in the operations division to help make these evaluation studies? These men are out there when it rains; they can obtain the data at a minimum of expense and effort. Why not use them? If present federal statutes do not permit this, why not undertake to get the statutes changed? Surely all of us as taxpayers are interested in effecting governmental economies that not only save money, but also result in increased efficiency.

3 *Determination of the economic and governmental issues involved in such questions as the division of costs of erosion control between the landowners and the public*. It will bankrupt the nation if all erosion control has to be paid for by the public. There is pressing need for a determination of how much erosion control society has the right to expect of the landowners, and for the development of methods which will insure that landowners actually live up to their just obligations in this connection.

While I am speaking of erosion research I also want to register a deep conviction. This research should largely originate in the field. Its administration should be decentralized, as in the U. S. Forest Service, and at all times be kept close to the problems actually interfering with field progress. I see no urgent need for much research of a general type that aims at nationwide application. Erosion is going to be controlled by the combination of many small, but highly essential, procedures or steps, taken by local people on a basis of methods specifically designed to meet the local conditions. I am frankly skeptical of any solution to the erosion problem that can come from big discoveries made at some central research center, and applied throughout the nation. I believe efficiency will require that at least 80 per cent of our research funds be spent in the field on projects which have originated in the field.

I also want to go on record as being out of sympathy with the present division of funds between research and operation. The field program is now recommending to farmers practices that have never been tested by research. Such a procedure is not only unwise, but also inefficient. We must in some way convince Congress that they are getting the cart before the horse. There is ample justification for the present appropriations for the field program. Still more money could be wisely spent in its support. There is no justification, however, for the contemplated reduction during the next fiscal year of the funds available for erosion control research.

The most pressing need of the operations program is for a declaration of public policy regarding erosion control on *all* farms, not just those in the U. S. Soil Conservation Service demonstrations areas or located adjacent to CCC erosion camps. Farmers want to know how much help, if any, they can expect from the public in controlling the erosion on their farms. Not over 2 per cent of the farmers of the nation are now signed up with the Soil Conservation Service and receiving federal aid thereby. The owners of the other 98 per cent of our farms, not signed up with the Soil Conservation Service, are waiting until the Soil Conservation Service moves into their neighborhood and gives them the same assistance it is now giving the 2 per cent.

President Roosevelt this past winter asked the state governors to sponsor legislation in every state providing for the establishment of soil conservation districts, which would have the power to compel a minority of landowners in a district to practice erosion control. The question is

likely to be asked, How can you justify compelling a minority of reluctant farmers in an erosion control district to accept governmental plans or aid when many more farmers outside the district want this aid and counsel and cannot get it?

The term "demonstration area" is in many ways a misnomer when applied to the areas on which the Soil Conservation Service operations staff is working. A demonstration should be contagious and result in more rapid acceptance of the new idea by the adjacent farmers. Actually the Soil Conservation Service demonstration areas often have the effect of *delaying* action on the part of farmers outside the demonstration areas. Naturally they decide to postpone erosion control until they get the same governmental help as those inside the demonstration areas, or adjacent to the CCC camps.

There is urgent need for definite announcement of public policy covering governmental aid to *all* farmers who will undertake to control erosion. This policy should extend into the future so as to permit landowners to make their plans on a basis of specific knowledge as to what aid they may expect from the government. Congress has given such assurances in connection with programs involving improvement of deep waterways, highway construction, forest fire prevention, land reclamation, and other similar undertakings dealing with the protection or development of our national resources. We cannot afford to delay any longer a like pronouncement of public policy as regards the preservation of what is by far the most valuable material resource of the nation, its soil.

One of my Wisconsin colleagues, E. R. Jones, has suggested that in the future an appraisal be made of the reasonable cost of any governmental help extended to private landowners in the control of erosion, when such control results in benefits to their lands. Costs would be based on what a private contractor would charge for similar materials and services. Each farm cooperator would be required to pay into a state soil conservation fund 75 per cent of the appraised cost, and the giving of the aid in the first place would be contingent upon such a promise to pay. With the fund which thus accumulated with the state soil conservation committee, other farmers could be given aid in erosion control activities to the extent of 25 per cent of their cost. In this way all farmers would be paying 75 per cent of the cost of controlling erosion on their farms, and the government the other 25 per cent. Such a policy would

1 Remove the incentive to delay erosion control work

2 Permit the CCC camps to remain longer in a given location without incurring the envy of other communities wanting governmental aid. (Much unnecessary expense is involved in the present frequent relocation of CCC camps)

3 Treat all farmers alike so far as governmental aid is concerned

4 Finance four times as much erosion control with the same investment of federal money.

Erosion control will also be much facilitated when we can secure either a complete divorce of our undertaking from the AAA production control program, or the adoption by AAA of the Soil Conservation Service interpretation of what a soil conservation program for the nation should be. I have much sympathy with those who desire to increase the income of American farmers by influencing prices of farm products through regulation of agricultural production. They have a worthy objective, but so do we, and our program is seriously handicapped so long as the two undertakings carry the same soil conservation banner, and the public is confused into thinking the two programs are similar, if not identical. Actually our objectives are widely different. The present AAA program puts major emphasis on the reduction of cash crops, and the increase of grass and legume acreage by about 15 per cent. A farmer can plow up and down the slopes, put all his cultivated crops on the steep lands, and still get the maximum AAA benefits. No one who knows the situation can by any stretch of imagination call such a program even half complete as a soil conservation policy for the nation. But the public is not likely to supply funds for an adequate soil conservation program so long as the man on the street thinks the $500,000,000 annually going into the AAA program is being used for this specific purpose. With the recent changes in Supreme Court opinions and personnel, it should be no longer necessary to put false whiskers on the AAA production control program.

If the AAA were willing to use its half billion dollars to stop soil erosion, and to provide adequate protection of the soil resources of the nation, they should promptly modify their regulations so that farmer cooperators can secure benefit payments only when they carry forward an effective, genuine soil conservation program. The AAA will then be supporting essentially the same field program as the Soil Conservation Service. If, on the other hand, the AAA is unwilling to do this (and I believe they can thoroughly justify their attempt at some kind of production control in an effort to improve farm incomes), they should promptly ask Congress for a legal separation, if not divorce, from the Soil Conservation Service. To fail to do so puts the whole erosion control program in jeopardy, and opens the AAA to the charge that they are willing to sacrifice the establishment of an adequate erosion control program in order to secure for their production control plan the prestige and good will which erosion control has won from the public, both city consumers and farmer producers.

That portion of the effort and cost of erosion control borne by landowners will naturally be largely in connection with activities farmers are capable of undertaking personally. The engineering phases of erosion control, however, are often too technical for laymen to attempt without guidance. Because engineers are thus likely to occupy a leading position in the public programs of assistance to landowners in controlling erosion, it will be particularly important for them to avoid the error of assuming that engineering occupies a similar leading position in the entire task of erosion control.

The plain fact of the case is that erosion control is primarily a matter of wise land use, and so managing the farming operations as to avoid growing the wrong crops on vulnerable slopes. This means more fenced woodlands, more grass and legume hays, and less cultivated crops and small grains on the steeper fields. The engineering features of such land-use planning are decidedly secondary. Engineers will do well to recognize the distinction between a complete erosion control program and that part of a control program that is being paid for by public funds. Engineering will likely play a major part in the latter program, but have less of the spotlight in the former.

Effective erosion control is a lot more than providing work relief for the unemployed, although there are few, if any, work relief projects more deserving of public support, or that have made a better record. If erosion is going to be brought under control, however, it will be because land operators, year after year, indefinitely into the future, are alert enough to detect, and to avoid, those farm practices which promote erosion, and to initiate those

practices which hold the soil in place. The labor and materials provided by CCC camps are invaluable in helping land operators to get started on an erosion control program, but it can only be a start. In the last analysis it is the landowners, and not the government, the CCC boys, not the camp engineers, that are going to save the nation's soil.

Someone might ask, "Why have farmers in this country been so slow to respond to the appeals of agricultural extension workers that they check the erosion on their farms before it becomes even more widespread and destructive?"

There are undoubtedly many factors that have been involved, but I believe the major one is our peculiar American policy of looking upon farming as primarily a commercial enterprise to be conducted on a money income basis. Farmers have had much the same attitude toward their farms as manufacturers have toward their factories. Make all the money you can, as fast as you can, and then move to some pleasant place to enjoy your earnings. Our American small towns have been notoriously filled with retired farmers, and it is claimed that all truly successful Iowa farmers go to California to die.

It has been hard to condemn this policy when life on a farm has been lonely and largely without comforts and conveniences. Any successful farmer would naturally move to a center where he could enjoy the privileges of our twentieth century civilization.

We are today, however, in the midst of a great revolution in the manner of living afforded to persons residing on American farms. Automobiles, good roads, telephones, and the radio, have broken down the isolation. Modernization of farm homes by providing central heating systems, electric lights and conveniences, running water, and sewage disposal, has greatly increased the comforts of country living. Engineers have been largely responsible for this significant change in attitude toward spending one's declining years on the farm. It is a service of which the engineers can be proud, and I think we are only beginning to realize the beneficial effects that will result.

When farmers start thinking of their farms as places where they find their comfort and enjoyment, and not just places where they turn their labor into money, it will make a great difference in their attitude toward soil conservation, the protection of farm woodlots, and the promotion of game and other wildlife. Mining land of its plant food and surface soil is less tempting as a farm policy when one no longer feels the urge to clean up all the money he can and get away to a more pleasant spot to enjoy the fruits of his labor.

In the years immediately ahead I look for a larger appreciation on the part of landowners of the possibility of creating in the open country of America, a mode of living that makes the farm the most attractive place in which to spend one's entire life, not just the early years. We shall see a growing realization of the interrelationship of conservation programs dealing with water, trees, soil and wildlife. Separate programs in these fields are much more expensive and less effective.

It is a challenge to all of us, and in particular to agricultural engineers, who have such an important role to play in bringing about the better kind of farm living, to do less of our thinking as single-track specialists in a restricted field of endeavor. We need the vision of what it will mean for this nation to have its rural people conscious of the need for conserving *all* our rural resources, both material and human. We have the chance here in the United States to build a permanent type of rural civilization that will far surpass in its comfort and its culture any similar development the world has ever seen.

A Method for Finding Terrace Cross Sections

(Continued from page 296)

The value in the table that is nearest this measurement is 20. The next reading, which is in column F_1, therefore, is taken opposite the 20 in column B_1 that appears opposite 15. The measurement of F_1 in this instance is 8 ft. Since there is no 8 in column F_1, it is necessary to interpolate. The value of the area is found in column F_2 as 15 per cent, since 15 is the value nearest the selected measurement 16. The reading in the F_2, 15 per cent column is found by interpolating between 20.9 and 26.9, the readings opposite 7 and 9, respectively, and is seen to be approximately 24 sq ft.

This measures only the ridge of the terrace. However, the same procedure can be used for finding the cross-sectional area of the terrace channel. For the sides of the channel the procedure would be the same as that explained in the preceding paragraph. If there is a flat part in the bottom of the channel, the cross-sectional area of this can be calculated separately and added to the channel area created by sloping sides.

Practice has proved that B_1 and F_1 are not difficult to measure even when the ridge is old and well rounded. A straight line down the slope, which is approximately an average of the curve, gives a sufficiently accurate measurement. In regard to the points between which measurements of B_1 and F_1 are to be taken, there is usually no difficulty in determining these on the front slope. On old terraces, the lower termination of B_1 is found by stepping back a few paces and surveying the intersection of the back slope with the original slope of the land.

The question of the accuracy of this method is one of interest. Measurements of cross-sectional areas will vary even when they are taken at very short intervals along the length of the terrace. There is, therefore, the possibility of getting a sample that is not representative, but this is no more likely than when any other method of measurement is used. Any method gives only an approximation. When the cross-sectional method is used, an error of considerable magnitude can easily be made in plotting the base lines and another in calculating the areas. These may amount to as much as 3 or 4 sq ft. It is believed that areas computed according to the method described in this paper are accurate enough for the purpose at hand.

A 5-ft strip of wood on which was mounted a regular carpenter's level hinged at one end and fitted with a graduated scale at the other proved to be as accurate as any other device for securing the measurements.

The method here proposed has these advantages: (1) Only apparatus is needed that is understood by the engineer and the farmer alike; (2) the cost of the equipment is nominal; and (3) it is possible for either farmer or engineer to check the terraces frequently and obtain accurate knowledge of their condition. Certainly this is something that could not be done by the methods that have been used in the past.

Corrosion Tests of Metals and Alloys in Spray Mixtures

By E. M. Dieffenbach

SPRAY materials used in orchard spraying are usually corrosive to metals and alloys. To determine which of the present-day materials are most resistant and therefore suitable for use in the construction of spray machinery and equipment, a series of tests was made by the Bureau of Agricultural Engineering, U. S. Department of Agriculture. For some parts of the equipment, such as nozzles, a suitable material must be resistant to abrasion also, but this quality was not covered in these tests.

The methods used in making these corrosion tests were selected as approaching actual conditions of service as nearly as practicable. In a spray machine the interiors of the various parts are usually subjected to periods of exposure to the spray liquid followed by periods of drying out. To simulate this condition, the samples of metals and alloys to be tested were immersed in agitated spray solutions (Fig. 1) for a period of 8 hr, then suspended above the liquid to dry out for a period of 16 hr. This cycle was repeated for six days for each pair of samples.

Duplicate samples were cut from material furnished by the manufacturer in most cases, the material being about 1/32 in thick. The samples were made in the form of disks of 1⅝-in outside diameter, with a hole of ⅛-in diameter in the center. Surfaces were prepared by touching them with emery cloth as the disk was revolved in a lathe, the last emery used being grade 00.

The spray materials used were two of the most common, as well as the most corrosive in use today, Bordeaux mixture and lime-sulphur solution. Fresh materials were mixed once each twenty-four hours, 500 ml (milliliter) in each beaker. The Bordeaux mixture was of the proportions: 3 lb copper sulphate, 4 lb hydrated lime, 50 gal water. The lime-sulphur solution was of the proportions: 1 part by volume of lime-sulphur (32 deg Baume) to 50 parts water.

The metal samples were weighed before the tests, after three days of the test, and at the end of the six-day run, weighing accurate to 0.00001 gram. The most satisfactory cleaning solution to remove the products of corrosion from each particular metal or alloy before weighing, as well as the loss of weight chargeable to the cleaning, was found by preliminary trials. The best cleaning method found for removing Bordeaux deposit from most of the samples was a 30-sec rinse in 10 per cent acetic acid at room temperature. A rinse in carbon bisulphide (under water) for 30 sec was generally the best method for removing the lime-sulphur deposit from the disk samples. In all cases the final rinses were in water and in benzine respectively, followed by at least 30 min in a desiccator before weighing.

Thirty metals and alloys were tested. The results with seventeen of them are shown in Fig. 2. There the losses in weight of the test samples are shown in milligrams per square decimeter per 24 hr. A loss of one milligram per square decimeter in 24 hr represents, for steel, removal of the equivalent of 0.00466 mm (millimeter), or 0.000184 in in thickness per year.

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Author: Assistant mechanical engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. ASAE.

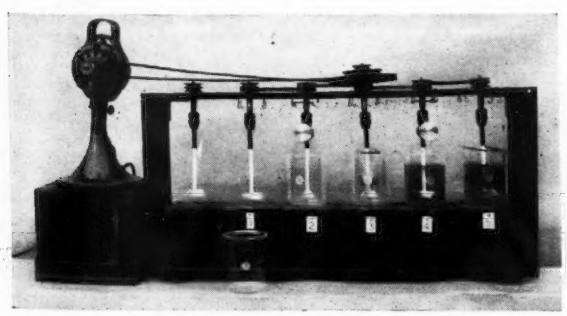

FIG. 1 APPARATUS FOR CORROSION TESTS. 1. Porcelain stirrer, 2. Stirrer inside of empty beaker with pair of disks suspended above, 3. Stirrer inside of beaker with pair of disks suspended inside of empty beaker, 4. Stirrer inside of beaker with 500 ml of liquid, with pair of disks suspended above, 5. Stirrer inside of beaker with 500 ml of liquid, with disks suspended in the solution

SUMMARY

It is known that in most cases the corrosive action on a metal or alloy alone will be different than when dissimilar metals or alloys are in contact, and it is also known that different heat treatments will sometimes change a material somewhat in its corrosion resistance; but it is believed that the tests outlined here will give a practical idea of the general corrosion resistance of the materials tested when subjected to Bordeaux mixture or to lime-sulphur solution.

Aluminum, whether 99 per cent pure or containing 4 per cent copper, is very resistant to lime-sulphur solution, and fully resistant to Bordeaux mixture.

Brass and bronze with a copper content up to 85 per cent were found to be fairly resistant to both Bordeaux mixture and lime-sulphur solution. A bronze with a copper

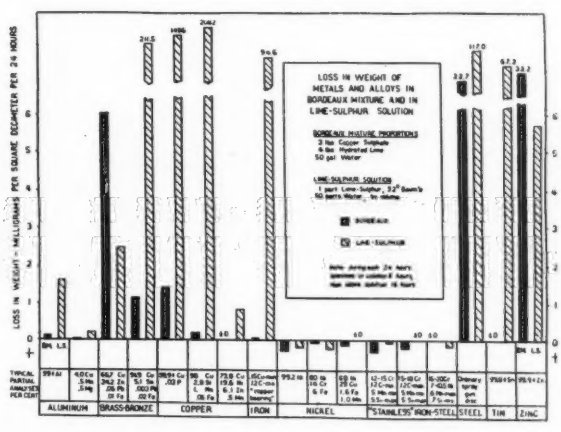

FIG. 2 LOSS OF WEIGHT SHOWN IN TESTS

content of 95 per cent was not resistant to lime-sulphur solution.

Pure copper was fully resistant to Bordeaux mixture, but was not resistant to lime-sulphur solution. The copper alloys tested were also fully resistant to Bordeaux. The alloy consisting of approximately 74 per cent copper, 20 per cent nickel, and 6 per cent zinc was fully resistant to lime-sulphur; but the one of approximately 96 per cent copper, 3 per cent silicon, and 1 per cent manganese was not resistant to lime-sulphur.

A copper-bearing iron with 0.15 per cent or more copper content was fully resistant to Bordeaux mixture, but was not resistant to lime-sulphur.

The three samples of nickel and nickel alloys tested were fully resistant to both Bordeaux mixture and to lime-sulphur solution. Their slight gain in weight in some instances was probably due to the inadequacy of the cleaning solution used previous to the weighing.

All "stainless" iron and steel tested was fully resistant to both Bordeaux mixture and to lime-sulphur solution. It is important to note that not only the alloy containing 16 to 20 per cent chromium and 7 to 10 per cent nickel was fully resistant; but also those with 12 to 18 per cent of chromium in the absence of nickel.

Ordinary steel spray gun disks taken from stock were not resistant to either Bordeaux or to lime-sulphur.

Pure tin was resistant to Bordeaux mixture, but not to lime-sulphur solution.

Pure zinc was not resistant to Bordeaux mixture, but was fairly resistant to lime-sulphur. Similarly, commercial galvanized iron was not resistant to Bordeaux.

Conquering Lister Ridges with Pneumatic Tires

By Edgar V. Collins

THE equipment described in this article has proven effective in holding a tractor on lister ridges for early cultivation of listed corn. A single tire is used on one side of the tractor and is set to center on a lister ridge. A dual tire is used on the other side and straddles the ridge. Using this equipment, it was found that with the tractor wheels in the lister furrows, the front wheels can easily be forced onto the ridge by using the wheel brakes, and then the rear wheels will climb the ridges from either side with no difficulty. This is because only one tire is climbing the ridge at a time.

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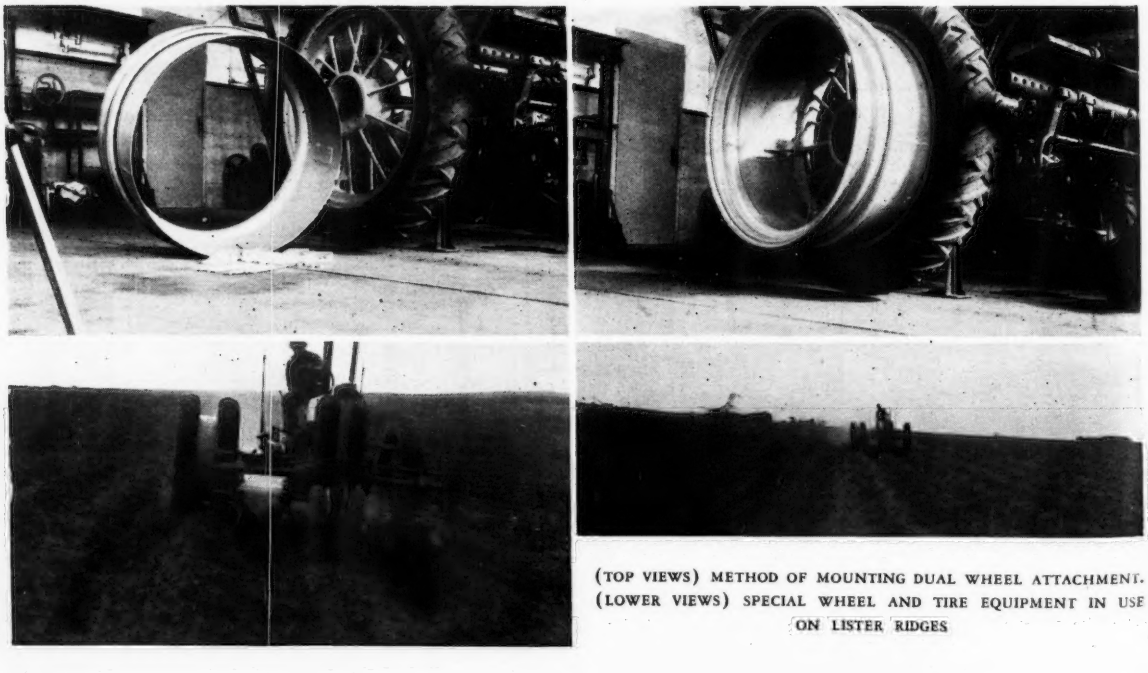
Author: Agricultural engineer, Iowa Agricultural Experiment Station. Mem. ASAE.

Tires used are the 7.50x36-in size. The mounting for the dual tire was made by welding a 12-in strip of 11-gage steel into a band that would wedge inside the flange of a 36-in rim. A standard 36-in rim was welded to this band and the whole unit clamped onto the side of the regular wheel. Reinforcing patches were welded to the band to strengthen the holes for the clamping bolts. As the tractor tire rim flanges are tapered, the clamping bolts wedge the band into the rim and no difficulty has been experienced with loosening. This equipment has also been used on the land wheel while plowing and is thought beneficial.

The author desires to make acknowledgement to the Firestone Tire and Rubber Company and to the John Deere Tractor Company for their cooperation in this experimental development.



(TOP VIEWS) METHOD OF MOUNTING DUAL WHEEL ATTACHMENT. (LOWER VIEWS) SPECIAL WHEEL AND TIRE EQUIPMENT IN USE ON LISTER RIDGES

Electrification of American Agriculture

By E. A. White

THE engineering of agriculture moves forward. The rate of this development ebbs and flows, but the net result is always in the same direction. The engineer believes in reducing the man-hours for various farm operations, improving living conditions, and making both the man and woman on the soil directors of power. The spade and the hoe—famed in art and literature—are foreign to the engineer's philosophy. In this school of thought it is not believed that "man should earn his bread by the sweat of his brow." Evidences of this transformation are to be found on every hand. What the farmer thinks of these possibilities even the most casual observer, with only a short memory, can see while driving through any of our better agricultural areas. Electric wires on the farmsteads, rubber tires on farm implements, are indicators of tremendous change. As with industry, so with agriculture—both continue to go mechanical. The transformations, the yet unrealized possibilities, delight the heart of the engineer, and stagger the imagination.

Into this stream of constant change there has come the electric current, making possible the operation of the electric motor, the electric light, the electric ray, the electric heating unit.

The year 1936 promises to be memorable in the mechanization of agriculture, for it marked the connection of the one-millionth farm to the electric "high line." According to the statistical department of the Edison Electric Institute, the number of farms with electric service on December 31, 1936, was 1,042,924. In addition to this, there were perhaps 300,000 farms using the individual electric plant. There can be no doubt about it—any service used by more than 15 per cent of the farms of this country has taken root in American agriculture.

The year 1936 also marks the first time over two billion kilowatt-hours of electricity were used by American agriculture in one year. The amount used, as reported by the statistical department of the Edison Electric Institute, was 2,138,446,000 kwh. The average use per farm per year was 2,050 kwh. The 24 states—one-half of the total number—in which the average use per farm per year was over 1,000 kwh are given here:

State	Kilowatt-Hours
2,000 and more kilowatt-hours	
Arizona	14,128
California	11,472
Louisiana	2,221
1,250 kilowatt-hours and less than 2,000	
Florida	1,910
New Mexico	1,779
Washington	1,764
Idaho	1,514
Oregon	1,455
Mississippi	1,451
Connecticut	1,434
Texas	1,411
Nevada	1,346
Montana	1,255
1,000 kilowatt-hours and less than 1,250	
Virginia	1,240
Georgia	1,204
Oklahoma	1,185
Massachusetts	1,147
New Jersey	1,135
Kansas	1,088
Alabama	1,062
Illinois	1,036
Maryland and District of Columbia	1,016
Pennsylvania	1,004
New York	1,003

Presented before the Rural Electric Division of the American Society of Agricultural Engineers, at Urbana, Illinois, June 22, 1937.

Author: Director, Committee on the Relation of Electricity to Agriculture. Charter Mem. ASAE.

So far as my knowledge goes, there is not a stationary operation on the farm today, indoors or out, in the doing of which electricity cannot be used. True, not all of these uses are considered to be practical at the moment, but even our fences are being electrified, insects are destroyed, plant growth is stimulated.

In contrast to this situation, we find the electric current almost entirely absent from the field of tractive farm operations. True, we have the electric truck, and the electric plow, but the use of this equipment in agriculture is so limited as to be negligible. Far be it from me to permanently exclude electricity from this most important farm power field. Developments of the past fifty years have been so numerous and far-reaching as to make what has—time and again—been pronounced impractical or impossible, the normal state of affairs. Why people of this generation should be surprised at any mechanical development is beyond my imagination. Some day we may find electricity an important factor in the field of farm tractive operations, but, it is my guess, not until we attain some fundamental development such as the Steinmetz blanket of power, or a storage battery of light weight and large capacity. The field is inviting. Perhaps even now some unknown individual is dreaming of the keys which will unlock this possibility.

Leaving the electric tractive field to the scientists and inventors, let us look at some of the possibilities which electric operation offers the farmer and his wife under present conditions.

Perhaps there is nothing, not even the invention of the stove or the coal oil lamp, which has as far-reaching possibilities for the farm home as electric service offers. Certainly no other service was ever made available to the farm home which offers the variety of possibilities touching the problem at as many vital points as that offered by the equipment which may be operated by electricity. It will set off the alarm which wakes the farmer in the morning, and turn off the furnace after he has retired for the night. Why enumerate these household services? We all are familiar with them. Suffice it to say that with electric service available, a farm home may be just as modern today as any other home located anywhere on this globe, even to air conditioning. It is no longer necessary to move to town to have modern living conditions. As one philosopher declared, "The automobile made it possible for the farmer to get away from home; now electricity makes that home a desirable place to stay." This single fact may have a most important bearing on our national development. It is an engineering achievement of the first magnitude.

We need perspective. It is said that today big figures are necessary to make an impression. Well, the radios on our farms with electric service represent an investment of more than 30 million dollars, while each farm home with lights, minor appliances, electric range, refrigerator, water heater and water system represents an electric investment of more than one thousand dollars. Multiply that last figure by a million, and you get a billion. And "One million well-electrified farm homes" is no wild flight of the imagination either. It calls for services needed by the American farmer.

Electric service is convenient—and how we do simply long for convenience! Light at the flick of a switch; water by simply turning a faucet; the pump or the furnace turned on and off without touching anything. Yes, electric service caters to the comfort and convenience of the individual. Often such service saves time and money; always it creates peace of mind, and it is especially conducive to physical comfort. This is no mere whim. It is an important engineering question. Why should man labor when he can make a machine which will relieve him of that labor?

In many instances the use of electrically operated equipment saves the farmer labor. This is illustrated in the milking machine, the brooder, the water pump, the stationary spray plant. True, part of this is merely a transfer of labor from the farm to the mine, the transportation system, and the factory. Unfortunately, we do not have specific information with reference to the relative amounts of labor involved in such transfers. However, until such time as there is proof to the contrary, the engineer will continue to believe there is a net saving in man-hours. That is, we believe there are less man-hours required to produce an electrically operated milking machine and milk a given number of cows with it during the life of the machine, than would be required to milk the same cows by hand over a similar period of time.

SOME JOBS BROUGHT TO THE FARM BY ELECTRICITY

On the other hand, there are instances where the use of electrically operated equipment on the farm takes labor from the city into the country. As an example of this, take refrigerated storage for agricultural products. To make the proposition more specific, take apples. With refrigeration on the farm, the storage is done here rather than in town. Even though the total amount of labor involved may not be as great, still there is more labor on the farm than would be the case with storage in town. The same general situation applies to egg storage, dressing poultry, bottling milk, or washing and bunching of vegetables.

The use of this same equipment may give the farmer desired control over marketing, maintain or improve the quality of his products, or enable him to produce a more nearly finished product. Spraying, quickly and at exactly the proper time, means better quality fruit. Refrigeration offers possibilities for lengthening the market season and maintaining the quality of the product. Soil heating means better plants. Irrigation is a necessity in arid regions and a crop insurance in humid areas.

Then, there are a number of possibilities not necessarily related but grouped here for convenience. Who would have thought only a few years ago that the efficiency of fences could be improved and the cost reduced by the use of electricity? We now pasteurize milk by passing the electric current through it. This same process may be extended to fruit juices and canned vegetables. Certain types of electric rays may be used to destroy molds and bacteria. Electricity has already been successfully used to combat insects. Who can predict where this development may lead? What are the relations of electricity to plant growth? It is known that mutations may be produced by use of the X-ray.

The situation may be briefly summed up as follows:

1 The electrical idea is established in American agriculture.

2 At the present time the rate of increase in farms served is the highest ever attained.

3 The use of electricity per farm is increasing at a rate comparable with other fields, and this situation gives every promise of continuing.

4 Potential possibilities are far from realized.

5 The changes to come from a further mechanization of agricultural operations are far-reaching and deserve more fundamental attention than has generally been accorded them.

6 The inventor, the engineer, the scientist will continue to search for improvements, new ideas, new developments.

ENGINEERING ANALYSIS NEEDED

With such possibilities facing us today, it is desirable that the engineer evaluate the changes in agriculture with yardsticks which he understands and which have proved their worth. From the electrical standpoint, we need an engineering analysis of electric uses on the farm. In fact, it is probably highly desirable that such an analysis be not limited to the electrical applications. We need an engineering analysis of agriculture.

In order to obtain information for an engineering valuation of what is happening in agriculture, we need to know:

1 The primary horsepower required for production operations by different types of agriculture. Here will be shown the relations between different types of prime movers.

2 The relation between primary horsepower and labor. Man-hours per horsepower should become as generally used and as well understood as bushels per acre.

3 The equipment investment for power purposes may well be standardized.

4 The influence of mechanical equipment upon the family farm, the tenant farm, the corporation farm, or the marginal farm, calls for an engineering treatment. In what direction does this influence point?

5 What about the size of farm which can be efficiently handled when the operations are properly engineered?

6 In fact, some study might very profitably be given to determining what is desirable engineering for farm operations.

7 What about the primary power in the farm home? Does anybody know today how much primary power is used in a farm home? It is my own belief that the average farm home is far underpowered.

Yes, there is ample opportunity for an engineering analysis of agriculture. Through it the engineer can make a still greater contribution to the freeing of the tiller of the soil from arduous labor, making farm life more attractive, and further insuring the quality and quantity of the essentials and luxuries required by the human family which, directly or indirectly, man annually wrings from the soil.

How Industry May Assist in Agricultural Progress and Prosperity

By Dr. Ralph E. Flanders

THAT the elements of society depend on each other is a truism. That no single element can long be depressed without affecting the others is a matter of established human experience and is a particularly striking phenomenon of our highly industrial age. I am especially glad to discuss the subject I have set for myself before this society of agricultural engineers, because you stand as the connecting link between two great divisions of our people. You stand with one foot in the realm of industry and the other in the field of agriculture. You would seem to bear, therefore, a very important part of the responsibility which we all share for mutual understanding and cooperation between these two great groups.

It is no part of my plan to criticize the ideas, attitudes, or policies of agriculture. I am concerned only with the question of what industry can do to assist agriculture, and to render that assistance in such ways that the health of the whole body politic will be enhanced.

Under proper conditions it would seem that industry can assist agriculture in the following ways:

1 By making among the industrial population a better market for the farmer's products;

2 By increasing the output and decreasing the price, or at least preventing the increase of price of the things the farmer buys; and

3 By furnishing profitable employment in industry to the surplus populations now dependent on agriculture.

There are two means of raising the living standard of a group of people which may be used separately or jointly. These two means are, first, redistribution of the volume of wealth produced and, secondly, an increase in the volume of wealth available for redistribution.

Looking at the matter negatively, may we not question the adequacy of the redistribution of wealth as the primary means for raising the real standard of living of industrial workers and farmers alike? So far as I know, we have no adequate figures as to the proportion of the production of goods and services which can be diverted from their present channels towards the masses of the people for the sake of raising the living standard. Such studies as were made by the Department of Commerce, for instance, three or four years ago indicated that in the long run, in the companies reporting to the Department, the average earnings were not much more than 5 or 6 per cent on the investment year in and year out. There is involved in this, of course, more than the question of dividends, since large salaries are involved and also the flow of interest from bonds and similar securities into the hands of those having large holdings. No studies that I have ever seen, however, of the distribution of wealth in the United States indicate that the amount which goes into the hands of the wealthy class would be sufficient, if redistributed, to meet the rightful needs of the mass of the people.

An address before the annual meeting of the American Society of Agricultural Engineers at the University of Illinois, Urbana, June 22, 1937.

Author: President, Jones & Lamson Machine Co. (Vice-president, American Engineering Council).

While there are possibilities of improving the justice of the distribution of wealth, these possibilities will fall far short of the standards we may properly set for ourselves, unless the amounts to be distributed are largely augmented by increases in industrial production. Redistribution will go only a short way towards our social goal. The major problem is that of greatly increased production precedent to improved distribution.

We may very properly raise the question as to whether or not we are now, at this moment, adequately equipped for the increased production required by a higher standard of living. There is need for a definite study of this subject as a base for future governmental policies. My own impression is that we are beyond the limits of production already from the standpoint of single-shift operation, and in many lines we are approaching the limits in double-shift operation, with three-shift operation as a fact in some lines in which continuous processes are not involved. This raises the question as to whether or not two-shift operation in industry is a part of the "more abundant life," and if not, whether we should not be making provisions for increasing our available productive equipment.

This question is, of course, one which does not affect the farmer directly. At times the requirements of his work compel him to labor for long hours. At other times his hours are short. This question is raised because it is a part of the main problem of wealth distribution with which the agricultural community is deeply concerned.

Pursuing this thought further, it would seem that thought, research, and analysis should be devoted to the question of what is the optimum division of the returns from industry between consumption on the one hand and savings and investment on the other. We may, I believe, assume that as the progress of invention and development slows up and as the rate of population increase slows up, a lessening percentage of our returns from industry will be required for the savings and investment stream. This percentage may be much less for the distant future. The vital question is what ought this percentage to be for the next few years. Among the things that savings and investment is required for are:

1 It must finance and equip society for a still growing population

2 It must finance and equip society for a rising standard of living in terms of an increased volume of goods and services

3 It must finance and equip society for shorter hours by the provision of more efficient machinery and labor-saving devices, if shorter hours are to be an element in our social objective

4 It must finance still further provision of equipment for the day shift, unless night work is to be considered an essential element for the future, or for two shifts, if only the third shift is to be eliminated

5 There must be enough savings and investment to make good the inevitable business losses. This element will, of course, be diminished by the more careful control of the issuance of new securities, but must not be carried

to the point where new developments are choked by the mistaken idea that all risk should be eliminated

6 There must be enough savings and investment to finance the research, experimentation, and development needed to continue our progress towards new products, better products, higher efficiency, shorter hours, and higher living standards.

Can we surely say that we have ever been overequipped, and can we surely say that too much of the wealth produced has flowed into the hands of those who save and invest as compared with those who consume and enjoy? The stream for savings in investment, from whatever sources, must be of considerable size if the foregoing tabulation is a valid one.

Yet, there have been times when it seemed quite obvious that the stream of wealth flowing into the hands of the well-to-do was much too great and that in certain lines at least the funds invested in capital expansion were much too large. It is proper in this connection to raise the question as to whether the funds which have flowed into physical investment in our boom times have not been derived fundamentally from inflation, rather than from the profits of legitimate production and distribution. We cannot prove this point with any data now at hand, but it is proper to raise it to see whether some light can not be thrown on it that will be useful in the development of future governmental policy.

In the new powers given the Federal Reserve Board and the Securities Exchange Commission, we have the means for preventing such credit sprees as we have suffered under in the past. In these controls we are more nearly touching the heart of our problems than we are in an endeavor to slow down physical investment for the production and distribution of goods and the rendering of services.

These considerations cannot be used to prove that we should not proceed with the redistribution of wealth. They merely indicate that there are limits to this process if we wish to increase the volume of wealth produced. We should be clear in our minds that that is our real ultimate objective—more production and consumption for more people with the agricultural group sharing in this increased production and distribution.

There are at this moment certain major forces in operation which, unless restrained or redirected, will make it very difficult to increase the volume of our wealth production. The forces referred to are those which are now effectively operating in the current strife between capital and labor. We may very properly criticize the detailed tactics of this warfare while remaining in thorough sympathy with its objective, so far as those objectives relate to an improved standard of living for industrial workers.

The problem presented by this current strife arises from the fact that its present course is in the direction of greatly increased wages for the same or shorter hours and for the same or less output per worker. The net result of this struggle, if successful in these immediate objectives, will be a largely increased purchasing power in the hands of industrial workers without any increased output of goods to be bought. This cannot fail to result—so far as industrial prices are concerned—in a rise in prices of the things produced at least as rapid as the rise in wages. It is true that the farmer's income will also tend to be increased somewhat by a corresponding rise in the prices of agricultural commodities, particularly such items as green vegetables and dairy products which are not affected by the world market. But these rises also are bound to be counterbalanced, or more than counterbalanced, by the increased cost of the manufactured goods which the farmer wishes to buy.

So far as the future welfare of the farmer depends on industry, the first question that arises is this: What labor policies will result in an increase of real wages to the industrial worker and make him a better customer of the farmer?

The answer to this question seems clear in general terms, although the practical answer for a given case is not so simple. Labor policies, to be useful to the industrial worker and farmer alike, must be such as to permit constant increase of output per worker so that there may be increased consumption per worker. No matter how high wages may rise, there can be no increased consumption unless there is an increased production.

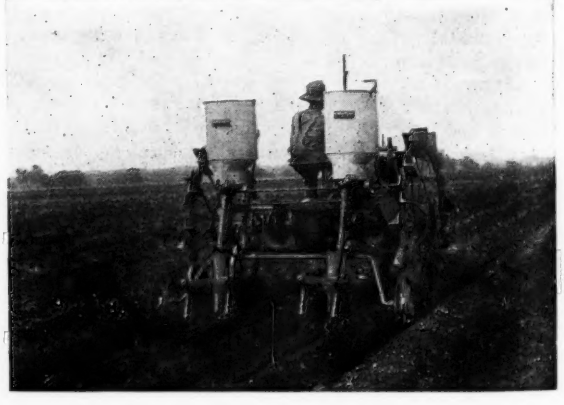
This increased production may be obtained by various means, some of which are socially desirable, while others are not. It may be obtained by longer hours or by more intense physical activity on the part of the workman. These are undesirable solutions. To be dependent on them would be to reverse the course of progress of our industrial civilization which has been continuously in the direction of shorter hours and less intense physical activity.

The desirable methods of accomplishing the desired ends are in the direction of better management so that a greater output can be obtained with less effort; more and better labor-saving equipment; and increased efficiency in distribution so that some of those now engaged in wasteful market processes may be made available instead for increased production. It will be seen from this that the farmer and the worker have a large stake in the continuation of industrial improvement rather than in any of the various forms of "technical holidays" that have been suggested by some misguided people.

A second question is: What are the proper monetary, taxation, and investment policies to permit decreased prices in the face of increased wages and shorter hours so that the farmer may purchase more with his income?

Here again the answer is clear in general terms, though it is more difficult to incorporate it in the form of concrete suggestions. In general, we may say that the control of speculation, which is now possible through laws passed in the last four or five years, should be a major element in steadying the processes of investment and expansion and enabling us to go forward on a balanced increase of output and investment in equipment for the purpose of lowering prices.

There is, however, one step *(Continued on page 310)*



THE FARM EQUIPMENT INDUSTRY IS ONE WHICH ASSISTS AGRICULTURE MOST DIRECTLY AND EXTENSIVELY

Why Build Better Farm Buildings

By William Boss

FEW of us can realize, until we have given the matter long and serious consideration, just how important the farm structures problem is and what a real opportunity it gives to us, as agricultural engineers, to have a part in helping to bring about better conditions; avoiding a much more serious financial depression than has recently been experienced; and at the same time bringing the standards of American farm life up to a higher and a happier level.

This can be accomplished only through proper education; education of our educators to the benefit or the curse to be had from the use of mechanical power; and education of our younger generation to an appreciation of the value of farm home life, as well as suburban home life, and of the fuller enjoyment of life for those who will learn how to plan and work intelligently, and look forward to the gradual development and final accomplishment of a carefully planned occupation and a useful place in society.

To obtain this result requires careful consideration of the principal factors involved, including among others the importance of such factors as mechanical power, improved machinery, and farm structures. Not only the importance of these factors to the farmer himself in doing his work, but also the part their manufacture or construction, including raw materials production or extraction, and transportation, play in providing employment for a large group of persons who are good consumers of farm products, and who, when thus employed, help to make the farmer's business more profitable. If, however, this group of persons are not so employed, they will be forced to go into the farming business themselves in order to get a living. When this happens, the farmer loses a consumer of his products. and he acquires a competitor who helps to increase agricultural production and lower the prices of the farmer's salable products.

As engineers, each one of us must do all that we can to help establish and maintain the proper balances between agricultural and industrial production, and to stimulate and increase the consumption of both agricultural and industrial products.

Not many persons seeking solutions for our present-day difficulties seem to be fully conscious of the benefits to be obtained from an engineering analysis, and so to take into consideration all of the important factors involved in their solution, perhaps we, as agricultural engineers, have been too modest in taking our part and in emphasizing the value of engineering methods in helping to solve some of our social and economic problems. Perhaps there is a false economics, an economics that proves by means of figures and charts that it does not pay to build buildings, that in fact nothing pays, that life is an expensive existence and not worth the price it costs. Such economics has a very damning influence in a country such as America where there is an abundance of resources and of men waiting for jobs.

Apparently too many of our agricultural engineers are not full-blooded agricultural engineers. Too many of us are like the scientist who stays in his particular field and does not get a broad view of the principal factors affecting our present-day civilization. We are only one-quarter blood or perhaps one-half blood, confining our interest to only one, or perhaps two, of the four principal divisions of our Society, instead of being interested in the whole field of agricultural engineering and being alive to our full duty and responsibility as engineers. If we are to be of service as agricultural engineers, each one of us must become interested in the whole field of agriculture and in the development of agriculture in such a manner as to provide, for those engaged in it, an honorable occupation and the opportunity for being good and desirable citizens.

In talking of depression, we tend to think too much of the stock market, the price of wheat, the situation in Russia, the production indexes, and too little of man himself. Man is the ultimate consumer, and without consumption production has no meaning. Man is also a producer, and it is as a producer that he earns the wages that make him a consumer.

We need to evaluate man's place in the economic setup. Mechanical power can now be produced in nearly every community for much less than eight cents per horsepower-hour. Man's physical energy is equal to about one-eighth of one horsepower. His value as a power unit doing work that can be done with an engine or a motor, is less than one cent per hour. It is obvious that man cannot continue to perform these tasks and earn a living wage. New tasks must be found for man to do. He must learn to perform them in order to earn his share of the benefits of machine production.

To make this change, the cooperation of capital, industry, and labor will be required, and every force of education and government must be enlisted. Our economic system has developed and changed so rapidly that we have been left behind, and it is going to be a mighty task to catch up.

I feel that I should not let this occasion pass without trying to impress upon you the importance of engineering in agriculture. We have engineered mining, transportation, medicine, communication, and manufacturing. I believe we are just starting to engineer agriculture. Being a charter member of the American Society of Agricultural Engineers, organized just 30 years ago, I have often been asked, "What is agricultural engineering?" and when in turn I ask, "What is engineering?" I usually find that the general public is not very well educated as to just what engineering really is.

If we accept the definition of American Engineering Council that "engineering is the science of controlling the forces and utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activity in connection therewith", we will find that engineering covers a very broad field and that it is one of vast importance. We should be very proud of our profession.

In our analysis of the definition, if we can agree that nature's materials are the chemical elements in their various forms and combinations, with which we can produce action

Presented before the Farm Structures Division at annual meeting of the American Society of Agricultural Engineers at Urbana, Ill., June 22, 1937. Approved as Miscellaneous Series Paper No. 360, University of Minnesota, Department of Agriculture.

Author: Professor of agricultural engineering (head of the division), University of Minnesota. Charter Mem. ASAE.

by simply changing their location, their temperature, and sometimes their pressure; and if in our search for nature's forces we can find such invisible things as (1) gravity, the force by means of which we obtain power from falling water, if we will but make and install the waterwheel; (2) chemical activity, that force which through affinity and repulsion gives us combustion or heat and fire, as well as cold and ice, or the ability to change temperature and obtain energy for mechanical power, if we will but make the machine, and find the fuel to operate it; (3) magnetism, that great positive and negative force partially residing in iron, which not only turns our compass needle north and south, but also enables us to transmit power at the lowest known cost, gives us electric lights, automatic controlling devices, energy for heating, cooling, humidifying, etc.—surely we will agree that these materials and forces of nature give to us as engineers a very large field in which to work.

I think we will agree also that this is the engineer's field rather than the field of the economist, the lawyer, the editor, the banker, the newspaper man, or the politician. If we care to select as a fourth force the probable spiritual force, embracing love and fear, which I believe is largely used in carrying out the last part of our definition, "the art of organizing and directing human activity in connection therewith", I am inclined to think perhaps we share the field with the preacher and the teacher.

In my opinion the world's greatest need at the present time is an education that will enable us to adjust ourselves to our tremendous productive capacity due to the use of machines and mechanical power, and to learn how to live with our accumulated wealth, comprised of both property and money. Machines are made to save labor; if they do not do this, they are discarded. Mechanical power, produced by gravity or chemical activity, is much cheaper than human power. The problem before us, then, is that of teaching man how to be a skillful, rapid workman rather than a power unit. Shorter hours of labor and a higher wage scale call for more technically trained workers.

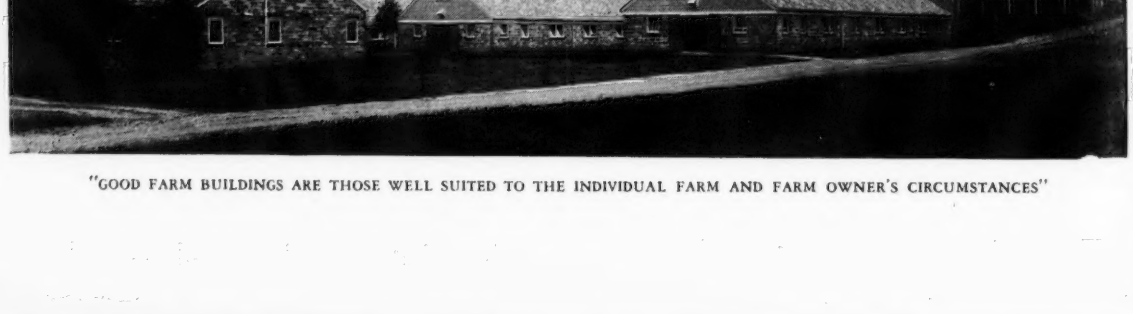
History indicates that when people are building, they are prosperous. This is due to the fact that workers consume not only food, which helps the farmer's market, but they also consume tools and building materials, the production of which gives employment to other groups of workers and keeps them out of the farming business.

We often hear the statement, "When the farmer prospers, everybody prospers," but I am inclined to think the reverse is true. When everybody prospers, the farmer prospers. When everybody is hard up and no building is being done, some persons are compelled to start farming in order to make a living. They require buildings, seed, tools, machinery, and other equipment. This helps business in general, calls workers from the farms, and brings prosperity to all.

It is similar to the old question, "Which was first, the hen or the egg?" We need both, and so we need both farming and other lines of industry. The successful farmer of today is a business man, and he knows that he must have machines and mechanical or animal power as best fits his situation.

My job as an agricultural engineer in an educational and research institution is a very interesting one. I get a great deal of advice as to just what is wrong and just what should be done about it. A great many socalled farm leaders tell me the trouble is due to the fact that some farmers are using too much machinery—too many tractors and too many automobiles—that the farmers themselves are largely to blame. They believe that farmers should use horses and thus produce their own power, produce more oats and less wheat and thus keep their money at home. These men are just as honest and sincere as I am, and they think they are right. Are they right? Would that solve the problem? My answer usually is that I am afraid they do not realize the development that has taken place in the past 200 years, and I try to point out as best I can how we seem to have come into a "machine age" and a "power age" in which we are now using mechanical power in place of animal and man power. I also tell them that I think we are just starting to come into an "engineering age" when we will learn how to adjust ourselves to all of our blessings.

We are living in a wonderful age. The works of man in our present-day civilization embrace a large and varied field of human endeavor. We probably are now at the highest stage of civilization that ever has existed on earth. It is certain that no civilization has ever before enjoyed the use of such inventions as the steam engine, the internal-combustion engine, the telephone, the radio, and the airplane. Practically all of these have been developed in the past century. How much further can we advance? Will we reach and maintain a normal period, or will we again decline? I do not know. In my judgment it will depend upon the kind of lives the people live. I am an optimist, and I hope and work for continually better things to come. We must realize that this is a matter for each individual to consider and each one should put forth his personal



"GOOD FARM BUILDINGS ARE THOSE WELL SUITED TO THE INDIVIDUAL FARM AND FARM OWNER'S CIRCUMSTANCES"

effort to bring about a lasting and continually higher state of civilization.

Many changes have taken place in American civilization in the past 100 years. These changes have been outstanding; they have affected industry as well as agriculture. As the United States has advanced in prosperity, people have left agriculture and engaged in other industries. This brought greater prosperity to those in agriculture who took advantage of modern machinery and improved methods of farming. This proves that agriculture prospers most when a large number of people are engaged in other kinds of industry and industrial wages are relatively high.

THE PLACE OF RURAL BUILDING IN SOCIAL AND ECONOMIC PROGRESS

Government statistics show that in 1800, 97 per cent of the people in the United States were agricultural. The doctor and the lawyer lived on the land and kept their own cow, horse and chickens, as well as a large garden. We had no steam engines at that time; they were just being perfected. Their success was due to the scientific knowledge that was being acquired, together with the mechanical skill of the mechanics who constructed them. We had no railroads and very little machinery. The ox and the horse were the only agricultural power other than human power. A rough estimate would indicate that by 1930, a period of a little more than 100 years, 25 per cent of our people had been taken out of agriculture, due to the development of the steam engine as a producer of power and the machinery it drives, together with its other uses such as heating, cooking, lighting, etc.

Twenty-five per cent more have been taken out due to the gasoline engine development in the building and operating of gasoline and oil engines, automobiles, trucks, tractors, highways, filling stations, airplanes, etc.

Another 25 per cent has been taken out due to the electrical developments that have taken place in the last 50 years.

This leaves 25 per cent engaged in the production of agricultural products at the present time. Government statistics give it as less than 25 per cent. What is the complaint? Some say overproduction. Is that true? Are we using too much machinery and mechanical power? What is the remedy?

The only remedy I can suggest is that we acknowledge these facts and adjust ourselves to the much better conditions which are easily possible for all mankind. One of the helpful solutions would be to make possible an era of home building and home ownership, to build better buildings, both rural and suburban. The building of educational buildings, schools, and churches, and maintaining the right kind of teachers to educate our youths to appreciate right living would do a great deal toward the return of lasting prosperity.

The farm building problem is an individual problem for each particular farmer. It depends largely upon his skill and ability as a farmer. It also depends upon the amount of capital he has or controls and the market for his products; exactly the same problems that confront the factory owner.

Good farm buildings are those well suited to the individual farm and the farm owner's circumstances. A good farm operator will work better and more efficiently with good buildings. If the buildings are poor, he usually makes them better or he gets another farm to operate.

If a farmer has no capital, or must work with borrowed capital, he is greatly handicapped unless he has unusual skill and ability. Probably he would be much better off working for someone who already has capital with which to purchase efficient machinery and pay good wages than to work in competition with him, handicapped for want of tools or equipment.

Our government has been in business for quite a number of years; fifty years ago it was giving away 160 acres of land to any of our people who would live on it and develop it as a farm and be able to pay some taxes. It also gave free garden seeds to encourage thrift among our farm people. It has set up agricultural colleges and experiment stations to help those who are engaged in agriculture to be more productive.

That we have all been benefiting by this activity on the part of the government is indicated by the following, taken from the statistical abstracts of the United States government in 1928, showing the increase in both agriculture and industry in the 25-year period from 1900 to 1925:

	1900	1925
Farm products	$3,549,000,000	$13,034,000,000
Mineral products	1,110,000,000	5,687,000,000
Manufactured products	5,123,000,000	26,778,000,000
	$9,782,000,000	$45,490,000,000

This is an increase of over 400 per cent. The farm population during this time was stationary, while our total population increased 50 per cent, or from 77,100,000 in 1900 to 115,000,000 in 1925. The per capita increase was from $128.00 to $394.00. Much of this wealth is not working at the present time. The only way to make it work is to find some means of making it become active.

The most needed activity in the United States at the present time and one that would benefit the greatest variety of persons is probably the building of homes; modern homes with proper heating, lighting, and sanitation. Such an activity would give employment to a great variety of workers, all of whom, when employed, are good consumers of agricultural products, and this is of direct benefit to those who produce or deal in agricultural products. A movement towards the building of suburban homes on lots of a few acres in size, on perhaps rough or nonagricultural land, looking eventually to a home, would no doubt be a great help in reviving permanent employment.

In order to give a concise and definite answer to the topic I was asked to discuss "Why Have Better Farm Buildings", I am offering the ten following reasons, all of which I hope can be accepted by persons who should be interested in agricultural progress and which we can defend as being good engineering:

REASONS FOR BUILDING BETTER FARM BUILDINGS

1 To help satisfy man's natural desire for the better things in the lives of himself and his children.

2 To more fully meet our continuous need for shelter for family, livestock, equipment, and products.

3 To obtain the economic returns that come from durable, long-time service construction.

4 To more completely fulfill man's obligations in "controlling the forces and utilizing the materials of nature for the benefit of man."

5 To increase the value of the farm. The value of a farm is based upon the quality of the buildings as well as the quality of the soil, about one-fourth of the value of the average farm investment is in its structures.

6 To make provision for the farmer to devote some of his own energy in helping to increase the value of his farm. Mechanical power and improved equipment enable him to do his field operations in less time; some of this time should be utilized in helping to build and maintain his buildings.

7 To provide work for the unemployed in the community. To give a man a job at reasonable wages is the best kind of charity; it enables him to keep his selfrespect and teaches him how to become selfsupporting.

8 To provide employment for common labor and workers in structural materials, and thus help to maintain a balance between agricultural and industrial workers.

9 To help maintain a reasonable balance of our accumulating wealth which consists of both property and money. More gold and silver is being mined and coined each year.

10 To keep our money in circulation. No money is consumed in creating a building; when the building is completed the money has gone to the workers. It has simply changed owners.

We have ample evidence that the power age has given to us a tremendously increased productive capacity. To enjoy the advantages of this age and keep in balance, we must increase our consumptive capacity. We must learn to waste intelligently, to dispose of the worn-out or inefficient, to preserve the good, to encourage improvements, and to encourage thrift. Growth and decay are natural processes. Nature may appear to be wasteful, but that is natural action, that is life. Old materials that have served their purpose must give way to the young or newer materials if we are to have life. Old buildings should eventually give way for newer and better buildings if our civilization is to be preserved or be made still better.

We, as engineers, interested in the welfare of those engaged in agriculture, must awaken to our own responsibility and definitely point out to those who are in positions of authority, the benefits to be had by all classes of people through a movement for better farm buildings, and the better things in life. We must study the problem diligently and develop our faith. Apparently we are lacking in faith, both in ourselves and in our fellow man, and I am sometimes inclined to think we lack faith in God, the same God in which our ancestors had faith, the creator of nature's forces and materials, and who has helped to bring the prosperity we have enjoyed in recent years.

I hope this meeting may help to stimulate our faith in engineering, as well as in building better farm buildings, and that we will resolve to be builders and not just "patchers and fixers up" of the most wonderful type of civilization the world has ever seen, in this part of the world called America.

How Industry May Assist in Agricultural Prosperity

(Continued from page 306)

which has not been taken but which is greatly needed. The government has in the last few years, by its relief program and in other ways, injected billions of dollars of new money into our banking and industrial system. We have now a volume of bank deposits that is without precedent. What is also without precedent in the face of such a volume of deposits is the very slow rate of turnover in their use. We are not enjoying "good business weather." There is a fear on the part of investors to invest, and until that fear has been removed from all proper and desirable types of investment, these funds are going to be held more or less liquid and stagnant, instead of being applied to the proper use of expanding and improving our industrial equipment for the production of more, better, and cheaper goods and services.

I believe that we have a thoroughly constructive feature introduced into our national economy in our new policies of governmental borrowing and spending during a depression. If these can now be supplemented by the corresponding policies of governmental retrenchment and debt repayment in a period of prosperity, and if in addition the administration can generate the right atmosphere for the recovery of individual enterprise in productive business, I believe that the results will be so far-reaching and beneficent that we may well conclude that we have passed a critical point in the history of our industrial civilization and that the crisis has been well met. Whether or not this happy event will prove to be true is not yet known; the result still hangs in the balance.

The direction in which we should be moving in our new balance between agriculture and industry may call for a considerable shift in population and in training this population for new work. In part, this takes place automent has in the the last few years, by its relief program continued periods of prosperity. There is then a continuous flow from the farms into industry of population seeking higher wages and better opportunities. That flow is a healthful one.

However, after so long a period of disorganization as that through which we have passed, there is perhaps need for it to be more definitely assisted and organized. We do stand in need of some better tabulation of the unemployment situation than we have at present. We need to know who they are and what they are. We need to know their ages. We need to know whether they have previously been in some industry or in agriculture; whether they are young people who have never succeeded in getting a foothold in industry; or whether they belong to stranded populations such as those of unneeded soft-coal miners.

Such a comprehensive survey of the unneeded or surplus population will be of great assistance in directing their steps into an expanding industry. If we are wise in our political, social, and economic decisions, industry will expand enormously—not merely in the number of industrial workers but more particularly in the volume of industrial output. In that expansion of industrial workers and output lies the best hope of the farmer for a better market for his products—more things to buy at less cost; and in a field of profitable employment for that surplus of farm population which has no future on the land.

There is need for us to study these things and for us to act—so far as occasion offers—as intermediaries between industry and agriculture so that they may be of mutual service the one to the other, instead of working at cross purposes. In such mutual understanding and assistance lies the hope for a better social organization than any we have yet enjoyed.

Comparative Tests of Fuels in Low-Compression Tractors

By E. L. Barger

BETWEEN 85 and 90 per cent of the tractors operating at the present time in the Middle West are of a low-compression type designed to burn a wide range of fuels[1]. In nearly all small towns in the agricultural sections there are five commercial grades of fuel available that could be considered as possible fuels for use in tractors. These include a premium-grade gasoline of 75 to 80 octane, regular-grade gasoline of 70 to 75 octane, third-grade gasoline of 55 to 65 octane, kerosene, and distillate. The character of the distillate will vary widely and is affected greatly by the fuel tax regulations in force. Typical of the distillate is a 38 to 40 API degree distillate in the range of a No. 1 fuel oil. It may vary from a 100 per cent straight-run product to one containing as much as 80 per cent cracked or pressure stock. It may vary from —7 to 40 in octane number. Few small towns carry stocks of distillate or fuel oil of the lower grades.

The five fuels were tested in two farm tractors in the agricultural engineering laboratories at Kansas State College and in one tractor in plowing, as a preliminary part of the fuel work being done in an engineering experiment station project on tractor fuels. It was the purpose of these tests to obtain information on the operating characteristics of each fuel and to compare them as to (1) fuel consumption, (2) fuel cost of operation, (3) maximum power developed, (4) crankcase dilution, and (5) adjustments and precautions necessary in their use when burned in tractors of the low-compression, wide-fuel-range type.

The tractors used in the tests were new, having been run only enough to limber them up properly. The first tractor tested, and hereafter referred to as tractor No. 1, was powered with a 4-cylinder, 4.75x6-in vertical engine. The compression ratio was 4.2 to 1 and the rated engine speed 1050 rpm. The manifold of this engine was equipped with an adjustable baffle such that heat could be directed onto the intake manifold when burning the low-grade fuels, and away from the intake when burning the gasolines. As regularly operated, water is injected into the intake manifold for an antidetonant when burning low-grade fuels.

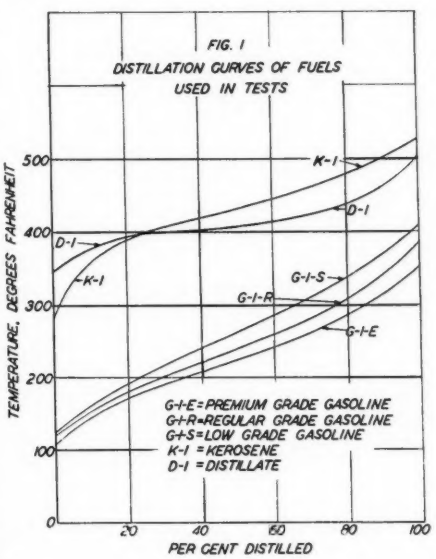
The other tractor used in the belt tests had a two-cylinder horizontal 6.75x7-in engine. It will be referred to as tractor No. 2. The compression ratio was 3.9 to 1 and the rated speed 900 rpm. There is no manifold heat adjustment, the intake being entirely surrounded by the exhaust manifold in such a way that sufficient heat is applied to vaporize low-grade fuels. Water used as an antidetonant is taken directly from the cooling system under normal operating conditions.

A large belt-driven prony brake was used to measure the power, corrections being made for brake windage and friction losses. An 8-in, 4-ply rubber belt was used, and no corrections were made for belt slip. The power reported is observed power.

The carburetors were reset for each load. A maximum power setting was used for maximum load tests. For loads less than maximum, a setting as lean as possible but giving no loss of engine speed was used.

Table 1 and Fig. 1 give some of the physical characteristics of the test fuels. Fuel prices listed in Table 1 are average prices at Manhattan, Kansas, as of May 25, 1937. While prices vary from time to time and from place to place, the price differential is of greatest importance and it is fairly constant.

An inspection of Figs. 2 and 3 shows that both tractors developed their full rated power on all of the fuels. Maximum power of 41.81 hp was developed with regular-grade gasoline in tractor No. 1 with the other fuels giving slightly less power as follows: Kerosene, 40.57 hp; low-grade gasoline, 39.94 hp; premium-grade gasoline, 39.50 hp; and distillate, 38.50 hp. Tractor No. 2 developed a maximum of 46.34 hp on low-grade gasoline and less with the other fuels in the following order: Kerosene, 44.85 hp; distillate, 44.15 hp;



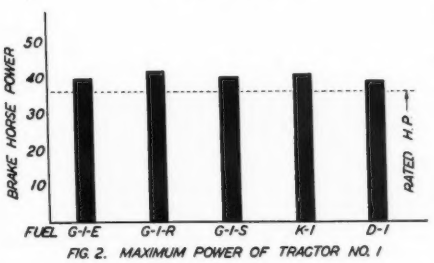


FIG. 2. MAXIMUM POWER OF TRACTOR NO. 1

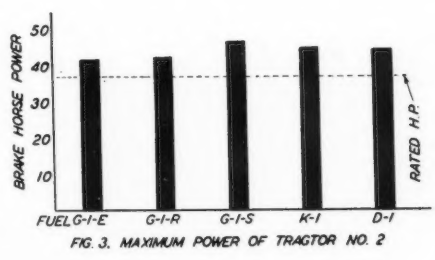


FIG. 3. MAXIMUM POWER OF TRACTOR NO. 2

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Author: Assistant professor of agricultural engineering, Kansas State College. Assoc. Mem. ASAE.

[1]Barger, E. L. "The Tractor Fuel Situation in Kansas," AGRICULTURAL ENGINEERING, Vol. 17, No. 6 (June 1936).

TABLE 1. PHYSICAL ANALYSIS OF FUELS USED IN TESTS

Kind of fuel	Gasoline premium grade	Gasoline regular grade	Gasoline low grade	Kero-sene	Distil-late
Sample number	G-1-E	G-1-R	G-1-S	K-1	D-1
API. gravity at 60 F	63.3	60.3	59.7	43.0	39.3
Specific gravity at 60 F	0.7264	0.7377	0.7401	0.8109	0.8285
Weight, lb per gal at 60 F	6.047	6.141	6.161	6.752	6.898
Heat Value—high Btu per pound	21,397	20,801	20,332	19,884	19,101
Heat value—high Btu per gallon	129,387	127,738	125,265	134,476	131,758
Price per gallon* (less state tax)	14.6	12.6	10.5	9.7	7.5

*Prices at Manhattan, June 25, 1937.

regular-grade gasoline, 42.26; and premium-grade gasoline, 41.98. These results are as might be expected since the engines were designed for low-grade fuels and the compression ratios in each case were low enough for the low-grade fuels but not high enough for the better grades of gasoline to make use of their potentially greater power-producing capacity through the use of higher compression pressures.

The specific fuel consumption in pounds per horsepower-hour varied but slightly with the different fuels. This is shown in Tables 2 and 3. A slightly higher specific fuel consumption resulted with kerosene and distillate, probably due to their lower heat content per pound and the greater difficulty of obtaining complete combustion.

TABLE 2. FUEL CONSUMPTION OF TRACTOR NO. 1

Run No.	Load	Engine rpm	Brake hp	Lb per hr	Fuel Consumption Gal per hr	Lb per hp-hr	Hp-hr per gal
Test No. 1. Premium-grade gasoline							
*1	¼	1122	9.26	13.82	2.27	1.502	4.07
2	½	1089	18.08	17.26	2.84	0.954	6.37
3	¾	1051	27.11	20.32	3.34	0.753	8.11
4	Rated	1041	35.79	23.82	3.92	0.664	9.14
5	Max.	1052	39.50	25.58	4.21	0.647	9.39
Averages		1071	25.95	20.16	3.32	0.904	7.42
Test No. 2. Regular-grade gasoline							
6	¼	1110	9.11	13.74	2.24	1.507	4.39
7	½	1099	18.34	16.92	2.75	0.922	6.66
8	¾	1076	27.40	20.90	3.41	0.762	8.03
9	Rated	1058	36.53	25.08	4.08	0.686	8.94
10	Max.	1064	41.81	27.58	4.49	0.659	9.31
Averages		1081	26.64	20.84	3.36	0.907	7.47
Test No. 3. Low-grade gasoline							
11	¼	1115	9.18	14.50	2.35	1.578	3.91
12	½	1084	18.06	17.88	2.90	0.991	6.23
13	¾	1068	27.49	21.14	3.43	0.768	8.03
14	Rated	1052	36.42	24.96	4.06	0.685	8.97
15	Max.	1058	39.94	27.68	4.48	0.693	8.91
Averages		1075	26.22	21.23	3.44	0.943	7.21
Test No. 4. Kerosene							
16	¼	1121	9.30	13.50	2.00	1.451	4.66
17	½	1102	18.16	17.88	2.66	0.984	6.83
18	¾	1060	27.13	22.80	3.37	0.840	8.04
19	Rated	1041	36.21	25.96	3.84	0.716	9.43
20	Max.	1061	40.57	28.96	4.29	0.713	9.45
Averages		1077	26.27	21.82	3.23	0.941	7.63
Test No. 5. Distillate							
21	¼	1113	9.19	15.50	2.24	1.686	4.09
22	½	1092	18.17	17.44	2.53	0.959	7.19
23	¾	1059	27.27	21.80	3.16	0.799	8.63
24	Rated	1029	36.03	25.94	3.76	0.718	9.60
25	Max.	1052	38.50	27.12	3.93	0.704	9.79
Averages		1069	25.84	21.56	3.12	0.993	7.86

*Average of 6 readings, 30 min test runs.

TABLE 3. FUEL CONSUMPTION OF TRACTOR NO. 2

Run No.	Load	Engine rpm	Brake hp	Lb per hr	Fuel Consumption Gal per hr	Lb per hp-hr	Hp-hr per gal
Test No. 6. Premium-grade gasoline							
*26	¼	944	9.20	12.90	2.13	1.401	4.31
27	½	925	18.90	16.00	2.64	0.846	7.14
28	¾	920	27.74	17.84	2.95	0.643	9.40
29	Rated	900	37.10	23.86	3.94	0.643	9.40
30	Max.	909	41.98	28.06	4.64	0.702	9.05
Averages		920	26.98	19.73	3.26	0.847	7.86
Test No. 7. Regular-grade gasoline							
31	¼	973	9.47	13.72	2.24	1.448	4.23
32	½	935	19.16	16.52	2.69	0.862	7.12
33	¾	917	27.82	18.66	3.04	0.662	9.15
34	Rated	904	37.42	23.96	3.91	0.640	9.58
35	Max.	906	42.26	28.90	4.71	0.684	8.98
Averages		927	27.23	20.35	3.32	0.859	7.81
Test No. 8. Low-grade gasoline							
36	¼	943	9.18	12.74	2.07	1.387	4.44
37	½	925	18.96	16.24	2.64	0.856	7.19
38	¾	916	27.63	18.54	3.01	0.671	9.18
39	Rated	910	37.73	23.72	3.85	0.628	9.80
40	Max.	903	46.34	29.24	4.75	0.631	9.76
Averages		919	27.97	20.10	3.26	0.835	8.07
Test No. 9. Kerosene							
41	¼	949	9.23	14.46	2.14	1.566	4.31
42	½	926	19.04	16.02	2.37	0.841	8.03
43	¾	915	27.63	18.72	2.77	0.677	9.97
44	Rated	903	37.34	23.26	3.44	0.622	10.87
45	Max.	909	44.85	30.28	4.48	0.675	10.00
Averages		920	27.62	20.55	3.04	0.876	8.64
Test No. 10. Distillate							
46	¼	944	9.23	14.50	2.10	1.570	4.39
47	½	927	19.01	16.18	2.34	0.851	8.11
48	¾	919	27.74	18.94	2.74	0.683	10.10
49	Rated	901	37.28	24.02	3.48	0.644	10.99
50	Max.	910	44.15	31.66	4.59	0.712	9.62
Averages		920	27.48	21.06	3.05	0.892	8.64

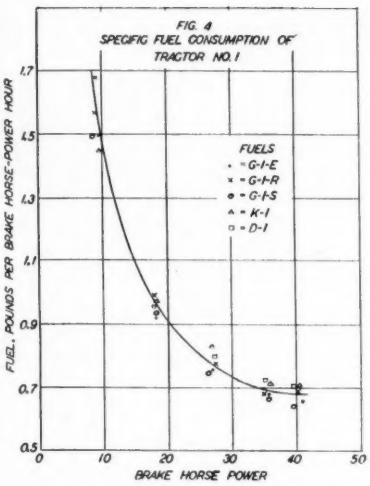
*Average of 6 readings, 30-min test runs.

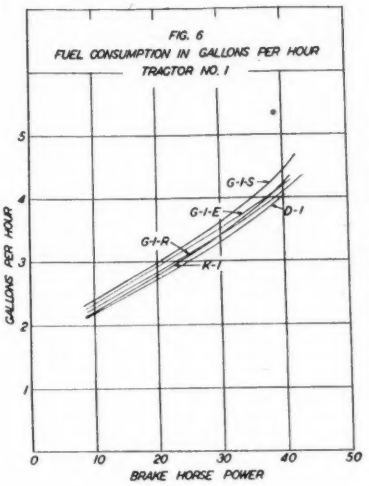
The last line in each test in Tables 2 and 3 are averages for the two and one-half hour test.

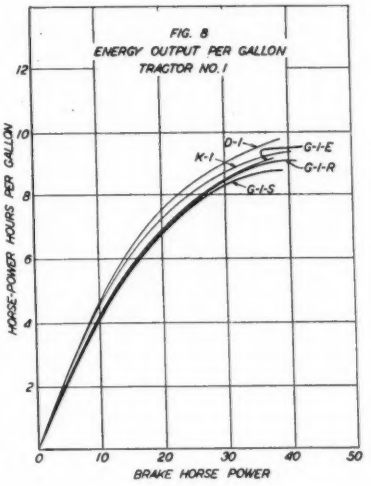
Of greater significance is the fuel consumption on a volume basis since fuel is purchased by volume and not by weight. This information is presented as gallons per hour in Tables 2 and 3. Figs. 6 and 7 show graphically the average fuel consumption in gallons per hour for each of the fuels. It is apparent from an inspection of these data that fuel consumption by volume is consistently lower with the low-grade fuels. At this point it is well to refer back to Table 1 in which the heating values of the fuels are reported. While the Btu per pound of the gasolines was slightly higher and the specific fuel consumption was lower with the gasolines, the greater weight per gallon of the low-grade fuels and their greater heat content per gallon result in economies in favor of kerosene and distillate in the low-compression engines tested. This saving in both tractors is approximately 0.25 gal per hr over a wide range of loads.

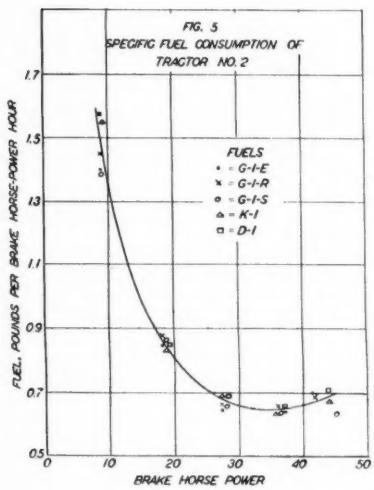
In the low-grade fuel-burning tractor it is not uncommon to obtain a greater energy output per gallon of fuel burned, with the lower grade fuels. A comparison of the fuels on the basis of horsepower-hours per gallon appears in Tables 2 and 3 and Figs. 8 and 9.

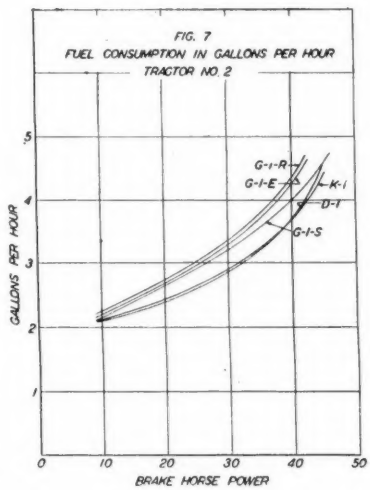
Tables 4 and 5 were prepared by multiplying pounds per horsepower-hour by fuel cost per pound. From these data, Figs. 10 and 11 were prepared. They show fuel costs to be about 40 per cent less with distillate than where a regular grade of gasoline was used. The difference in

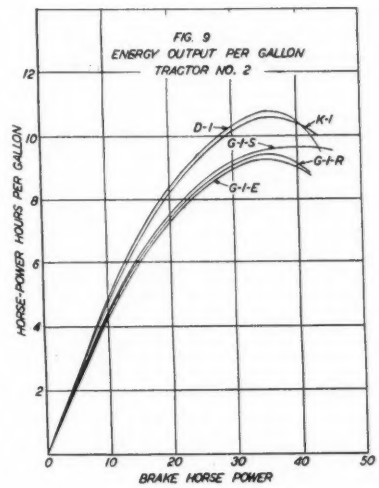












the fuel cost of energy output is made up of the two factors, price and energy output per gallon.

Fresh oil was supplied to the tractors at the beginning of each test, and at the end of the test samples of crankcase oil were taken to analyze for dilution. Two methods were used to determine the amount of dilution. The first was a distillation test and consisted essentially of heating

TABLE 4. FUEL COST IN CENTS PER HORSEPOWER-HOUR FOR OPERATING TRACTOR NO. 1

Fuel	Price per gal, cents	Load ¼	½	¾	Rated	Max.
G-1-E	14.6	3.63	2.30	1.82	1.60	1.56
G-1-R	12.6	3.09	1.89	1.56	1.41	1.35
G-1-S	10.5	2.69	1.69	1.31	1.17	1.18
K-1	9.7	2.08	1.41	1.21	1.03	1.02
D-1	7.5	1.83	1.04	0.87	0.78	0.76

TABLE 5. FUEL COST IN CENTS PER HORSEPOWER-HOUR FOR OPERATING TRACTOR NO. 2

Fuel	Price per gal, cents	Load ¼	½	¾	Rated	Max.
G-1-E	14.6	3.38	2.04	1.55	1.55	1.69
G-1-R	12.6	2.97	1.77	1.36	1.31	1.40
G-1-S	10.5	2.36	1.46	1.14	1.07	1.07
K-1	9.7	2.25	1.21	0.97	0.89	0.97
D-1	7.5	1.71	0.92	0.74	0.70	0.77

TABLE 6. RESULTS OF DILUTION TESTS OF CRANKCASE OIL

Fuel test No.	Fuel used	Running time, hours	Distillation method Total dilution, per cent	Distillation method Dilution, per cent per hour	Gravity method Total dilution, per cent	Gravity method Dilution, per cent per hour
1	G-1-E	4.00	0.80	0.20	0	0
2	G-1-R	15.00	6.70	0.45	0	0
3	G-1-S	6.25	1.80	0.29	0	0
4	K-1	8.50	14.00	1.65	9.40	1.10
5	D-1	2.66	7.80	2.93	5.20	1.95
6	G-1-E	6.87	0.50	0.07	0	0
7	G-1-R	6.47	2.50	0.40	0	0
8	G-1-S	4.47	1.00	0.25	0	0
9	K-1	8.82	14.70	1.66	6.20	0.70
10	D-1	5.15	8.70	1.69	5.30	1.03

TABLE 7. WATER USED AS AN ANTIDETONANT IN FUEL MIXTURE, IN POUNDS PER HOUR

	Fuel	Load ¼	½	¾	Rated	Max.
	G-1-S	—	—	—	—	—
Tractor No. 1	K-1	—	2.8	13.2	19.8	20.8
	D-1	—	—	3.0	12.4	13.0
	G-1-S	—	—	—	—	11.1
Tractor No. 2	K-1	—	—	4.7	14.0	24.0
	D-1	—	—	1.8	12.1	21.0

a sample of the crankcase oil in a distilling flask to a predetermined temperature. The percentage of dilution was considered as the percentage of the sample driven off below 735 F. The second or check method was to compare the gravity of the used oil with that of the new oil and the fuel. Any decrease in gravity was considered as being due to dilution with the lighter fuel. The first method is apt to give results which are too high because the light ends of the original oil may be driven over and some cracking may take place. The second method should give results which are too low since the fuel which goes into the oil will be the heavier ends and will not be represented by the gravity of the whole fuel. It was not possible to hold the running time the same in each test. Therefore, these dilution tests should be taken as indicative only of the tendency of the various fuels to dilute crankcase oil. The results of the dilution tests are shown in Table 6.

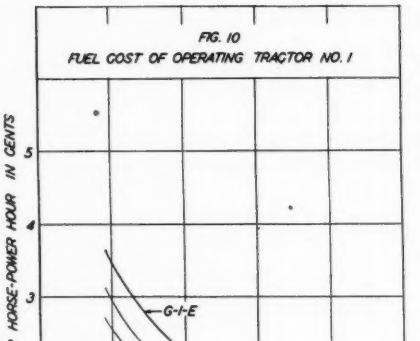
In general, the gasolines were more convenient to use. Odors and fumes from the exhaust were less offensive with the gasolines.

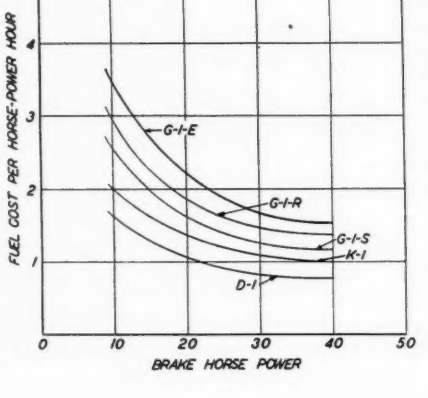
The carburetor settings were read in degrees opening of the load jet. It was found that a setting of from 30 to 60 deg greater opening was required for kerosene and distillate than for the gasolines.

Operation of the tractor engines was erratic, on loads of one-half or less of the rated power, when burning kerosene and distillate. Raising the radiator curtains to maintain the cooling water at temperatures of from 190 to 210 F partly corrected this difficulty. At quarter and half loads it was necessary to use the radiator curtain, with room temperatures as high as 80 F, to maintain engine temperatures sufficiently high to handle the low-grade fuels.

Water was used as an antidetonant whenever detonation was severe enough to cause any power loss. In one case only (tractor No. 2, maximum load, low-grade gasoline) was it necessary to use water with any of the gasolines. Water was required when operating on kerosene and distillate for all loads above one-half load, and a small quantity was used with kerosene at one-half load with tractor No. 1. Table 7 reports those fuels and loads with which water was required and the quantities in pounds per hour that were required to successfully suppress the knock.

Tractor No. 3, which was used in the plowing tests, was a general-purpose type tractor equipped with rubber tires. It was powered with a two-cylinder, horizontal, 5.5-in bore by 6.5-in stroke, 975-rpm engine. This tractor is designed and recommended to burn low-grade fuels.





A two-bottom, 14-inch plow was used. It also was equipped with rubber tires.

The field selected for making the tests was upland with an Oswego silt loam classification. It was in sorghum stubble, and the ground was dry, hard, and would be considered as difficult plowing. It was possible to plow in second gear (3 mph on steel wheels rated speed), with all of the fuels, at a 6.5-in depth.

Table 8 shows the results of these tests. There was slight detonation when burning kerosene and, as will be seen in the table, less was used per acre than of the other fuels. These results were verified by numerous check runs, and in other tests it has been shown that lower fuel consumption will be obtained with low-grade fuels when a slight detonation occurs. Had the load been slightly heavier, causing the detonation to be more severe, the fuel consumption with the kerosene would no doubt have been equal to or higher than other fuels.

On a gallon-per-acre basis for this low-compression tractor, the advantage is with the low-grade fuels, largely due to their greater weight and lower price per gallon. The fuel cost per acre for plowing was 55 per cent lower with distillate than with premium-grade gasoline, 46 per cent lower than with regular-grade gasoline, and 35 per cent lower than with third-grade gasoline. While the tractor engine operated satisfactorily on all of the fuels, it should be remembered that this tractor, being a low-grade fuel machine, does not permit the high anti-knock gasolines to be burned with the maximum possible efficiency.

It is again emphasized that the tests here reported compare the fuels mentioned only as to their performance in low-compression engines. No comparison as to their performance in engines of higher compression ratios is indicated nor implied.

TABLE 8. RESULTS OF PLOWING TESTS WITH TRACTOR NO. 3 BURNING THE VARIOUS FUELS

Kind of fuel	Area plowed, acres	Depth plowed, inches	Speed in mph.	Fuel per acre, lb	Fuel per acre, gal	*Price fuel per gal, cents	Fuel cost per acre, cents	Fuel cost in per cent
Premium gasoline	1.154	6.5	3.26	16.80	2.75	14.6	40.15	100
Regular gasoline	1.154	6.5	3.29	16.44	2.64	12.6	33.26	83
Third-grade gasoline	1.154	6.5	3.25	16.76	2.73	10.5	27.72	69
Kerosene	1.154	6.5	3.29	15.65	2.32	9.7	22.50	56
Distillate	1.154	6.5	3.26	16.47	2.39	7.5	17.92	45

*Fuel prices at Manhattan, May 25, 1937.

Terrace Project Planning

By C. L. Hamilton

DURING the last few years the field of terrace project planning has expanded greatly, as has the amount of field terrace construction work. The federal agricultural extension service reports show that many states are now reporting several hundred thousand acres of terracing annually, and a few report over a million acres. Only a short time ago they were reporting less than half this amount. County agents of the extension service reported that over 4,500,000 acres were benefited in the United States during 1935 by terracing and soil-saving dams; the same reports for 1930 show an aggregate of only slightly over 1¾ million acres. A further review of these reports shows that by far the major portion of this work was done in the southeastern and midsouthern states. This expansion in terrace construction work alone demands that more thought be given to terrace project planning so that the work can be carried out more effectively and economically.

Heretofore, terrace planning has consisted primarily of the details involved in planning a terrace system preparatory to the construction work. Making the field reconnaisance survey, determining terrace spacing, grades, length, cross section, methods of staking, realignment, plowing out, and construction is about all that has been considered in planning terracing work. Agricultural engineers have developed and are continuing to perfect this part of terracing work in a fine manner. They have done much experimenting and have made extensive field observations of terracing under actual field use and, as a result, have been able to establish rather definite terrace construction specifications.

The other aspect which has more recently been recognized deals with terrace project planning activities preparatory to the actual field planning or staking of a terrace and outlet system. This part should receive first consideration in developing a terracing project because it covers such items as are involved in developing and organizing a community for extensive, efficient, and effective terrace construction work. Community programs have many advantages over those that involve only scattered cooperators. Greater interest and accomplishments with reduced supervision and construction costs are the main advantages. Selecting the most suitable type of terracing equipment and developing the most satisfactory method of making it available for field work; determining and developing the most suitable educational program; and providing adequate supervision in the most efficient manner are also of importance. The problem of correlating terracing work with sound land-use and soil-management programs, as well as with other erosion-control measures and new developments in producing farm crops, is of primary importance. Engineers should take a more active part in matters of this type than they have in the past.

It cannot be said that engineers have neglected or overlooked this field altogether because they have taken the initiative in promoting terracing educational work, in advocating the use of county equipment, and in organizing county associations so that satisfactory equipment could be made available for terracing work. But much of this work has been done independent of complete conservation programs and there is much more involved than just the equipment and educational phases. The work that has been started may need some readjustment or improvement, but most important of all is expansion and coordination so that it will be in harmony with the national movements and activities in soil conservation work. It is hoped that agricultural engineers will devote more thought to this phase of terrace project planning in the next few years and that more definite and coordinated recommendations will be forthcoming. They must take a more active part in complete program planning, particularly where work of an engineering nature is involved, in order that the engineering aspects will have more adequate representation in the initial planning of such programs.

The need for this will be more thoroughly appreciated when the extent of the field and the necessity for the work is realized. The recent expansion of erosion control activities, the trend toward more complete programs, the formation of county soil conservation associations and the more recent movement toward the formation of larger conservation districts are ample evidence of the extensive field for this work. The contrast between the strength of the present soil conservation program, which has been developed under a more complete and coordinated method of approach, and the weaknesses of the initial erosion control efforts, in which scattered yet related problems were attacked from independent angles, is ample evidence of the need and advantage of planning complete programs from the top down. The majority of the basic field construction specifications and the value of terracing have been reasonably well developed, so it is now time for the engineer to do some complete terrace project planning from the top down.

Land Use Planning. Since the limits to which various soils and slopes can be used for cropping purposes are largely dependent upon whether or not satisfactory erosion control measures can be established, two things must be known before adequate land use programs can be formu-

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Author: Agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. Mem. ASAE.

CONSTRUCTING TERRACES WITH A 10-FOOT BLADE TERRACER AND TRACK-TYPE TRACTOR

This type of equipment has been used quite extensively for terracing in areas where it can be purchased and used cooperatively

lated and the most economical erosion control measures introduced: First, the limiting slopes for various soil types and farming conditions upon which satisfactory erosion control measures can be established; and second, the minimum erosion control measures or combination of measures that are necessary to provide adequate erosion control on various slopes and farming conditions.

In conjunction with terrace planning work, there is much yet to be learned as to the exact conditions under which terracing is necessary or the limiting conditions under which other control measures will provide adequate protection against soil erosion. At the present time there is much controversy over this point because available experimental data is rather limited, has not been fully accepted, and present opinions are largely based on personal field observations. Until adequate and conclusive experimentation has been conducted, it will continue to be a controversial point in the establishment of complete and definite erosion control recommendations. Consequently, engineers as well as conservationists will be handicapped in the most effective terrace correlation until such information is made available.

Proper land use planning is fundamental to the establishment of a sound erosion-control program, and the agricultural engineer can make valuable contributions to the most effective land-use planning. He has particular training in the use and application of the mechanical soil and water conservation measures that are fundamental, in many cases, in determining to what extent certain lands can be used profitably for various purposes. For example, whether or not an irrigation or drainage system can be economically installed often determines whether or not certain areas can be used for agricultural crops and other less favorable ones retired. Whether it is practical to construct an adequate system of terraces and outlets often determines, to a large extent, whether certain sloping lands can be safely used for cultivated crops. The practicability of the run-off diversion, gully control, stream bank revetment, or the use of artificial waterways, are also often instrumental in determining how land can be used most advantageously. Whether satisfactory wells can be drilled, water impounding dams constructed or surplus rainfall retained by mechanical means are important problems even in determining the most satisfactory manner in which range land can be used. The efficiency and adaptability of various field, building, and machinery arrangements are also problems that have distinct agricultural engineering aspects in complete farm planning.

It is the engineer's knowledge and training in these particular measures that makes his consultation of particular value in planning a program of land use. The most discouraging situation that the field engineer often encounters is that he is expected to carry out the engineering work that has resulted from land use planning when engineering counsel was either not available or not solicited before final plans were formulated. Under these conditions, it is not uncommon to find programs established on the assumption that certain engineering measures will be used. When the engineer is called upon to carry out the work involved, he often finds local conditions, the slopes, the topography, the drainage, or the soil structure of such a type as to severely hamper the construction work anticipated. If he is to carry out the work as originally planned, he must install certain engineering measures under the most trying conditions when the results may never be entirely satisfactory and chances of failure are high. On the other hand, if he refuses to carry out the original plans he is often criticized as being noncooperative, which may jeopardize his future. Such a situation usually leads to misuse of the measures involved, inefficient planning, costly and impractical construction, and undependable results, as well as general dissatisfaction. Much of this can be avoided if the proper procedure is followed in the original planning.

A FIELD TERRACE SYSTEM

On topography of this type, considerable ingenuity must be exercised in planning the most satisfactory farm terrace system

Developing a Terracing Project. After an adequate land use program has been developed for a community, it is then in order to prepare plans and organize for carrying out the various measures to be employed. It is important that a coordinated approach be developed cooperatively and agreed upon by all interested agencies. Each cooperating agency should be assigned the part of the program it is most capable of carrying out and each should work with the same general objective and procedure in mind. One of the most important assignments is that allotted to the local people and landowners. They must carry definite responsibilities and take active parts, particularly in the application phase of the program, or no lasting accomplishments can be expected. Many programs fail because the supervising agencies lack definite agreement and coordination, but more extensive failures or lack of accomplishments are due to the fact that the local people, and particularly the landowners, are not sufficiently interested or given definite responsibility for the work.

Should the conservation program call for extensive terracing work, a major problem is involved in developing suitable plans and organization for accomplishing this objective in conjunction with the other necessary supplementary measures. Since the introduction of major soil conservation measures usually requires basic changes in farming practices and, since terracing is an extensive earth-moving operation, a two-phase program seems to be necessary for most satisfactory results. One phase will involve the educational work and the other the operations work. While each phase of the program is dependent upon the other for final accomplishments, they are quite distinct in nature and are organized for different objectives. The former is for the purpose of showing the need for terraces, creating a desire for terracing work, and teaching farmers how to maintain or farm with them. The latter is for the purpose of providing the necessary supervision and equipment for doing the work in the most economical and satisfactory manner.

The education program is of primary importance in an area where landowners do not appreciate the need of conservation work, or are unfamiliar with the necessary change in farming practices and the maintenance work involved.

In communities of this type it is necessary that a well-planned education program, involving lectures, literature, pictures, demonstrations, tours, as well as other measures customarily used by the extension service, be conducted in advance of extensive operations activities. Sufficient educational and demonstrational work must be conducted so that the landowners are not only willing but anxious to introduce and maintain necessary conservation measures before much can be accomplished in the way of introducing an extensive operations program.

Once the need develops for extensive field work, the problem of primary importance in terrace planning is the establishment of the necessary agencies for doing the job in the most efficient and satisfactory manner and in accordance with the general conservation program for the area. Adequate supervision must be provided for planning and directing the field construction work. Probably one of the most important factors in the success of a terrace project is the type and training of the man in charge of the field planning. While certain fundamental engineering training is essential, a high degree of theoretical training is not as important as the faculty of good, sound judgment combined with an agricultural background and general understanding of the various phases and measures of erosion control. Once the general field layout has been established, the routine work of staking the terrace lines can be satisfactorily done by assistants who understand the use of leveling equipment and the basic principles of terracing. Lack of sufficient supervision and the use of supervisors who do not thoroughly understand or appreciate the need for good terrace construction are primary reasons why so many large areas of poor terracing are found throughout the United States today.

Terrace construction is a machine job that requires special machinery, not generally available on farms, for the most efficient and effective work. While much terracing has been done and will continue to be done by farm power units and small equipment, this is not the most satisfactory or economical procedure when labor is considered. It is usually difficult, and in some cases impossible, to secure terraces with ample cross section and channel capacity with this procedure.

The most satisfactory and economical terracing can usually be done with the heavier tractors and terracing machines now available for the work. The initial cost of this equipment is comparatively high and it is impractical for each farmer to make such an investment for his own terracing work. It therefore becomes necessary to provide means whereby the individual landowner can take advantage of the more desirable terraces and economical construction costs resulting from the use of this equipment, without the necessity of making such large initial or overhead investments. This objective is being accomplished by several different methods and each seems to have its disadvantages and advantages as well as particular adaptation to certain local conditions. Few of these methods have been conducted over a long enough period to warrant any definite priority rating at the present time.

In some states, counties are authorized to use county road equipment, or to use county funds to purchase terracing equipment. Farmers usually pay the operating costs and, in some instances, small additional amounts to cover any proportionate part of the equipment charges. Where state laws do not provide for this procedure, groups of local farmers are often organized into an association, purchase machinery and rent it out to farmers for terracing work on a cost basis. In some areas where there is ample demand for terracing private contractors are entering this field and seem to be doing the work in a very satisfactory manner. In other instances, one or more farmers purchase a terracing outfit and after they complete their own terracing they contract to do their neighbors'.

Lastly, but by no means of least importance, is the matter of terrace maintenance. This is an important part of terracing work that has been badly neglected in the past. It is safe to say that in many states there are more ineffective than effective terraces and either the lack of or improper maintenance is largely responsible. The idea that terraces can be constructed and left to take care of themselves is a false conception that is responsible for much of the dissatisfaction with terraces and the poor accomplishments found today. The matter of assuring proper terrace maintenance is one item that must be given primary attention in future terracing projects, or extensive and definite accomplishments will be difficult to point out in later years.

In closing let me reiterate that there are two phases to terrace project planning: (1) planning the design and construction details of a terrace system; and (2) planning the proper correlation of terracing with other erosion control measures for the most suitable land utilization program and how the work can be carried out most effectively. While both are of basic importance, it appears that the latter has been given the least attention by engineers. Recent trends in erosion control activities indicate that it should have more engineering recognition and be considered an additional field for agricultural engineers.

Farm Machinery Trends in Europe

By R. B. Gray

HAVING spent the years 1910 to 1920 in Europe in the employ of a large exporter of farm tractors and machinery, I was glad to have the privilege of returning during the summer of 1936 to observe the progress that has been made in the development and use of agricultural power and equipment during the past sixteen years. It is true that in some countries small grain was being cut with hand sickles, but combines, both large and small, were at work. Oxen pulling wooden or metal-shod plows were still in evidence, but rubber-tired tractors pulling steel plows were in common use.

With respect to power in Europe, the trend has been, as in the United States, away from the large, cumbersome, prewar tractor, to the small tractor built along automotive lines.

In Germany three trends were particularly noted: (1) the use of small tractors of about 10 hp; (2) rubber tires on all small tractors and on about half of the larger ones, as well as on field machines; and (3) the use of oil-burning tractors. It might be of interest to note that all rubber now is imported, but a synthetic rubber of better quality has been made which, however, at present is high in cost. Tractors other than diesels do not seem to be in favor, and one American firm is said to be building or has completed a factory in Germany for the production of diesel tractors. One large German firm builds many two-cycle, semi-diesel tractors.

Germany imports a large percentage of her fuel oils, although some are obtained from wells near Hanover. Some liquid fuel is produced from the hydrogenation of coal, and a considerable quantity of alcohol for blending with gasoline is produced. The quantity being distilled is said to be gradually decreasing because the farmers are unable to supply raw materials. The alcohol blends are used mostly in automobiles and trucks.

Fuels used for agricultural purposes are tax free. Ordinarily one would think of fuel for use in a motorcycle with side car as taxable, but I saw one carrying a calf a few weeks old, the owner probably maintaining his right to the tax exemption.

Tractors are being used extensively in England. In a tractor demonstration at the Royal Agricultural College near Cirencester, some 25 to 30 makes of tractors were operating. These included both track-laying and wheel types, many of the latter having rubber tires. Some rubber-tired machines had movable lugs, which by the rotation of an eccentric at the hub were moved out to project a few inches beyond the tire tread. The use of rubber tires on field machinery was popular and appeared to be increasing. The fuel apparently most used in England is kerosene, which is much cheaper than gasoline and costs about the same as diesel oil.

Denmark does not make much use of tractors, mainly because the farms are small. Rubber, however, is used on pulled equipment, and, it might be said also, on pushed equipment, for "push bikes" seem to be the popular means of transportation, if one may judge by the thousands he has to dodge in crossing the road in Copenhagen during rush hours.

In Sweden, rubber is used on drawn equipment but not much on tractors, for in the main agricultural region, in the southern part of the country, the soils are so heavy and the rains so frequent that rubber tires give poor traction. A Swedish semi-diesel tractor is becoming popular, although some American tractors burning kerosene are much in evidence.

France appears to be making fairly extensive use of tractors, as many new ones, especially of American manufacture, were to be seen. Diesel-engined tractors were numerous, some burning socalled gas-oil similar to our furnace oil. The larger tractors are mainly for heavy plowing, as in the case of beet growing, and the smaller or one-plow machines for cultivating. Rubber tires are provided on many of the small tractors.

About 20 per cent of the tractors in Italy are of Italian manufacture, mostly wheel-type, whereas a large portion of the rest are foreign made and largely of the track-laying type.

In both France and Italy, practically all motor fuel must be imported. These countries, therefore, foster especially the development of any kind of fuel that can be produced within their respective borders. They have done much research work in the development of portable gas-producer plants for making gas from farm waste products. Germany has experimented similarly in making gas from wooden blocks. For tractors, however, the generators and appurtenances developed so far have been too heavy to be practicable, hence diesel oil, so-called gas-oil, and kerosene appear to be the principal fuels. Alcohol blends, up to 20 per cent alcohol content, have been used satisfactorily, but in most of the countries are not popular because the alcohol adds to the cost of the already high-priced motor fuels. In Italy, kerosene is tax free if used for agricultural purposes and then is colored red so that inspectors can easily determine whether it is being misused. It was said that there is a law in Italy requiring the addition of 25 per cent alcohol to gasoline for motor fuel, but I was told that, because of the scarcity of alcohol, little if any is used in blends.

Tractor testing in England is done at the Agricultural Engineering Institute at Oxford, where the routine followed is more or less like that at the University of Nebraska. In Germany, the tractors are tested on a cinder track at Bornim, under the direction of the Reichskuratorum. The dynamometer car consists of a large tractor chassis which is pulled backward, the steering wheels being free but the motion restrained. The drawbar pull is transmitted through a hydraulic cylinder to the recording chart on the dynamometer car. The fuel consumption is recorded for 100 meters travel. The effect of type of tread on traction of rubber tires was tested, but no differences were noted between the various tires tested, which included some with smooth treads.

In Sweden, all machines marketed must be tested at the agricultural testing station just out of Stockholm, and the results published for the benefit of the farmers. Tractors are given a 5-hr load on a water brake, then limbered up on the drawbar for 5 hr, after which 500 hr of field

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Author: Senior agricultural engineer, and chief, division of mechanical equipment, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. ASAE.

work was done, this in an attempt to establish reliability of operation and performance.

The American plow, although used considerably, is not in general favor in Europe. This is partly because there they wish to plow one way only, so that no open furrows or ditches will be left in the field. As a rule, too, the furrows are smaller, and the moldboards are less abrupt than ours, although one farmer stated that American plows could not be used on his place because they could not go deep enough for his purpose. Cable plowing is done with steam engines and with electricity, but both types are passing out of the picture. Cultivation is practiced not only in row crops, such as sugar beets, but also in small grain. Seeding of small grain is done generally by machinery, although in some countries it is done by hand. Potatoes also are frequently planted by hand. Commercial fertilizer is sown with drills or special spreaders, but little has been done in studying its placement. Manure generally is hauled to the field and dumped in piles from which it is spread by hand. Liquid manure is used extensively in some regions.

In France, most of the plowing is done with balance plows and two-way plows (called one-way there). A few electric cable plowing outfits were in use.

Germany still makes use of steam cable plowing outfits (some twenty or more years old) on the larger farms. Considerable attention is being given to subsoil studies, particularly plow sole, and a unique type of double plow, with one share above the other, has been developed under Dr. C. H. Dencker's direction, I believe. By breaking up plow sole and establishing a certain relationship between the soil, the soil moisture, and the air space, crop yields under certain soil types and conditions have been considerably increased. Increased yields of small grain resulting from cultivation have been sufficient to justify the operation, which is performed by beet cultivators with shovel spacing altered. Generally four cultivations are made. Potatoes are planted by hand in holes formed in ridges by rotating paddles, after which they are covered by a middle buster going down the middle. One woman can plant about 2.5 acres per day.

Considerable commercial fertilizer is used in Germany, as is also barnyard manure, which is hoarded until properly rotted and then spread on the field by hand. Extensive use is also made of liquid manure. A unique quick-loading, liquid-manure tank was seen on one farm. It is loaded by means of a vacuum produced through an explosion of gasoline in a secondary tank. The explosion caused a sudden outrush of air through a large valve which closed quickly thereafter and the resulting vacuum drew the liquid into the tank through two pieces of large hose fitted with check valves. It is said the tanks would be filled about three-fourths full per explosion. This outfit could also be used to remove water from flooded cellars.

In England, steam cable plows are still used to some extent but are rapidly disappearing. One significant type of tillage was the use of the girotiller which is gaining some favor, particularly where root crops such as mangels, are grown. It is, however, a heavy consumer of power. This outfit stirs the soil to a depth of perhaps 15 or 18 in and breaks up plow sole, but brings very little subsoil to the surface and does not expose many dormant weed seeds. Commercial fertilizer is used considerably, but not much work is being done on placement studies. Barnyard manure is commonly spread by hand, although the use of spreaders is increasing. Apparently not so much importance is attached to the husbanding of manure as in Germany.

In Denmark and Sweden the use of fertilizer and manure is more or less similar to practices followed in Germany, except that in Sweden use of the American type of manure spreader is increasing.

Harvesting small grain in most of the countries is done largely in the conventional way, using binders followed by threshing with stationary threshers. Many of the threshers have recleaners. Germany has two unique binder attachments for handling lodged grain, one of which is a long tapered roller specially wound with a metal bar to aid the outside divider in parting the grain; the other is a mechanism which causes long fingers to reach under and raise the lodged grain. Combines, however, are becoming more and more prevalent. There are a few in France, Italy, and Germany, but their use has probably increased most rapidly in England. There are now about 75 combines in the British Isles, with Scotland and Ireland each having 3 or 4. About half of the total are large combines, and half are small with 5 to 6-ft cutter bars. Sweden has 3 or 4 combines. Germany and Australia have each produced a push type of combine, and some of this type have appeared in England.

In Italy, rice is often harvested by hand. On one farm the workers were equipped with rubber boots and hand sickles.

Potatoes are, in general, harvested by European diggers which have a revolving device for kicking the vines aside. The potatoes are then picked up by hand, mostly by women. In some cases, as in Belgium, large hoes are used for digging potatoes.

Sugar beets are raised in most of the countries visited. The prevailing method of harvesting is probably by hand pulling, although American beet lifters are sometimes used. In southern Sweden, American lifters had been tried out, but considerable difficulty was encountered in removing the clay from the beets. Considerable experimentation was done to develop a machine to overcome these objections, but the attempt was abandoned and they are now pulled by hand, laid in rows, and topped. In some localities the tops are plowed under. In others, they are ensiled.

The harvesting of hay is carried on in various ways. In some localities in Germany, a common method is to use a scythe and cut enough hay each day for the requirements of the stock. Some mowers, of course, are used. In England, hay is mowed with a mower and considerable use is made of buck rakes and stackers. Frequently an old second-hand car is purchased and a type of push rake is mounted in front, which makes a cheap but effective outfit. In most of the other countries the hay is mowed, tedded, raked in windrows, and frequently piled on racks in the field for curing.

Soil dynamics is a live subject in at least two countries. At Rothamsted, England, among other things, careful studies are being made as to just what factors are responsible for draft. As an example, one study was being made of correlating the draft of a tool with the force required to push a slug of the soil with a given moisture content through a glass tube. A specific gravity measuring device also was under investigation. This involved measuring the distance a certain weight (about 12 in in diameter, and flat) sinks in a given soil during each of several 10-sec intervals of time.

In Germany, studies of plow sole and subsoil are being made. In certain soil types and conditions it has been found that the yield of a crop can be considerably increased if the porosity is increased. Studies are under way of the effect of electric current on the draft of plows. As mentioned in another paper, direct current was passed from

an insulated knife colter to the plow moldboard which also was insulated from the frame. Some tests have shown a 20 per cent draft reduction between a standard single-furrow plow and one treated with 75 to 100 watts of direct current. Work of a similar nature is under way with a two-furrow plow. A new type of apparent-specific-gravity measuring device was being tried out in Germany. This consists of a ball which is dropped a certain distance, the depth of penetration being the apparent specific gravity constant. An interesting slow-motion picture was shown of the action of soil particles as a concave disk blade passed through the soil, which gave an idea of the relation of the shear planes to the disk and to the distance the soil was thrown.

The processing of farm crops varies considerably with the crop and the country. In Germany, which raises a large portion of her potato crop for hog feed, the potatoes are frequently cooked before feeding. This feed, which more or less takes the place of the corn ration in this country, is stored in air-tight pits until used. Corn, sunflower, straw, etc., are placed in brick or concrete silos, which are as a rule some 12 ft in diameter and some 15 or 16 ft high, with 4 ft or more below ground. Sometimes hydrochloric acid is placed on occasional layers of ensilage to hasten fermentation.

Germany is giving the question of seed cleaning and seed treating very careful consideration, and has embodied some excellent ideas into equipment. In seed cleaning they make use of an air blast, shakers, and a sloping, revolving, cylindrical sieve. In seed treating, a mist of poison is sprayed into the seed falling from a hopper into a revolving cylindrical drum built into a special machine. At first they soaked the seed with the poison solution, but spoilage took place rapidly. That was called the wet method. The present scheme is called the brief-wet method.

The processes of drying crops vary considerably, from curing in the field, as in the case of hay and shocked small grain, to artificial drying.

In Sweden there is a type of drier, built into the barn, which consists of several vertical zigzag shafts about 18 in wide by 10 ft long by 15 or 20 ft high, each with a spiked drum at the bottom which can be rotated by hand to aid in pulling down the dried hay. There is a 5 ft space at the bottom into which hot air up to about 120 F is blown through a large automobile type radiator. Hay is fed into these shafts and the hot air passes upward and out. Wood, which is cheap in Sweden, is used for fuel to heat the water in the boiler which supplies the radiator.

In England several types of driers are being sold. One of the latest is a tray type which promises to become popular. Coke is used for fuel, the hot gases of which are blown under two sections containing mats of hay. The section with green hay is arranged so the hot gases pass through the mat and out, until the hay is about half dry, when it is pitched by hand into a second compartment with a cover. Here the gas passes through the half-dry hay and back to be reheated. There are two additional compartments, symmetrical with the first two, which are being prepared while drying is taking place in the others.

I would like to close by mentioning a European practice which we could well follow in the United States. Old, broken-down, worn-out machinery is, in general, conspicuous by its absence over there. Either the machines are traded in before they fall to pieces or they are sold to the junk dealers after they do fall to pieces. At any rate, they disappear. Would not now be a good time to revive the campaign started a few years ago, to "cash in" the unused machinery and improve the appearance of our farms? We might adopt as a slogan the title of one article published in that campaign: "Junk the junk."

The Problem of Soil Tilth

IT IS the opinion of the committee that one of the most important problems in connection with research on the effect of various tillage operations on soils is that of defining tilth and measuring the effect of surface working tools upon soil tilth.

In our present state of knowledge, either from an engineering or an agronomic standpoint, we have no measuring stick by which to evaluate the efficiency of any tillage operation. Results are judged merely by the rule-of-thumb method. The establishment of standards of measuring the tilth result of a given tillage operation would have many fields of usefulness. For example, the engineer would then be in a position to integrate power expenditure in the field with change in tilth. It would be possible to evaluate from an engineering standpoint the merit in different sequences of tillage operations.

This problem of soil tilth has been discussed and written about a great deal in the past without anything definite having come of it. It is suggested that the proper way to tackle this problem is to enlist the cooperation of the soils people and also the agronomy group. The question of soil tilth involves a number of factors such as moisture content, amount of organic matter, colloidal content, etc. The soils people have been considering the same problem and have not gotten very far towards a solution.

The committee, therefore, recommends to the administration of the American Society of Agricultural Engineers that the Society propose to Soil Science and also to the American Society of Agronomy that a joint committee be formulated consisting of representatives of these three groups. The function of this committee would be to consider and study the question of soil tilth and the problem of devising methods of measuring the degree of tilth under any particular set of conditions.

Apparently there is no uniformity in the symbols used to represent the various forces and resistances in connection with tillage tool tests. The committee has made a start in suggesting a standard system of symbols to represent the various forces involved. It is important that this work be done because this type of research is new and the reports will be more valuable if a standard system of symbols is adopted.

Terms that are used to represent certain soil reactions to tillage operations should be defined. In some cases, terms have been rather loosely used and several terms are used to express the same idea. It is recommended that this committee, or perhaps the proposed new joint committee, proceed to formulate recommended definitions of certain terms used in discussing tillage work.

Respectfully submitted,
J. F. Reed
A. W. Clyde
O. W. Sjogren
John A. Slipher
G. D. Jones
A. J. Schwantes, Chairman.

A contribution of the ASAE Committee on Soil Preparation and Tillage for 1936-37.

NEWS

Urbana Meeting Sets New Record

WIDE range of activity, technical interest, sentiment and reflected progress characterized the thirty-first annual meeting of the American Society of Agricultural Engineers at the University of Illinois, June 21 to 24.

A challenging outlook on agricultural engineering became, in fact, the keynote of the meeting, as speaker after speaker in the general and division sessions matched convictions as to the social and economic need for agricultural engineering, with facts as to what this branch of the engineering profession has done and can do in its field, by right of its fundamental position and training. Optimism generated by the opportunities pictured was balanced by respect for the responsibilities involved.

An unexpected corner on some good weather, credit for which went to K. J. T. Ekblaw, provided temperatures usually below the upper limit for a comfortable coatless meeting.

The registration desk, opened for business at 1:00 p. m., June 20, found immediate customers and was kept busy throughout the week rolling up between 600 and 700 registrations and acting as general service agency for the convenience of guests. Audio amplifiers broadcast information and reminders to the lobby audience, to keep the meeting moving along on schedule.

While the Woman's Building was the center of activities, Lincoln Hall, the agricultural engineering building, and the engineering college laboratories were subcenters of interest, and the whole University was open to inspection.

Strong attendance at the scheduled sessions, and a minimum of lobbying during those sessions, showed popular approval of program arrangements and subject matter.

The University radio station, WILL, gave generously of its broadcast time to take the meeting to its audience in Illinois and neighboring states. Broadcasting of several of the sessions wholly or in part was supplemented by special broadcasts of talks by prominent agricultural engineers present, aimed to better inform the listening public of work being done by agricultural engineers, and of improved methods and equipment they have made available to farmers.

First assembly on the program, an entertaining and informative illustrated lecture on "The Lincoln Country," by Dean Rexford Newcomb of the University of Illinois college of fine and applied arts, Sunday evening, was well received.

By Monday morning the College Division was present in force to participate in its full schedule on extension, education, and research. Basic principles, progressive methods, and development of personnel were emphasized.

Features of the Monday evening picnic on the South Campus included soft ball games, rolling pin throwing contests, chicken and hog calling contests, a walking relay race, a rooster driving contest, an archery demonstration, a box lunch, moving pictures of typical features and activities of the University of Illinois, and a verbal and moving picture invitation to attend the annual meeting of the Society, to be held at Asilomar, California, on the Pacific Coast somewhere south of San Francisco, in June 1938.

The proposed revision of the Society's constitution was the center of discussion at the business meeting. Several present expressed a desire that provision be made for more continuity in the work of the divisions, and for coordinating their efforts more closely with each other and with those of the Society's Council. The matter was finally referred to the Council with a recommendation for special consideration.

Record attendance at the annual dinner created a food-handling and distribution problem, but the crowd would not have its spirits dampened and filled in the time with spontaneous group singing. The varied program offered heart-touching sentiment in the spirit with which the McCormick medal was presented to and accepted by C. O. Reed; inspiration in the announcement of a new John Deere medal to be awarded by the Society, in the presentation of the FEI Award to the Ohio State Student Branch of the Society, and in the ceremony of R. U. Blasingame turning over the president's gavel to Arnold P. Yerkes; music in vocal selections by Miss Mary Bane Lehmann, and piano solos by the head of the music department at the University of Illinois; and wit by J. P. Fairbanks, toastmaster, and several assistants.

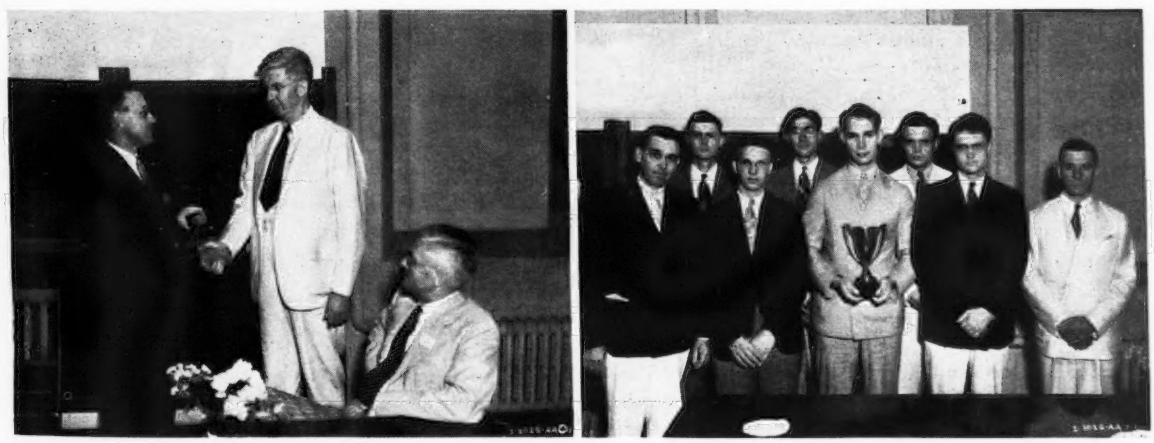
Following the dinner those attending returned to the Woman's Building to top off the evening with a dance in the gymnasium, and with other entertainment.

Between seventy and eighty agricultural engineering students, from Oregon in the northwest to Georgia in the southeast, were present to take part in the student sessions, to meet and hobnob with each other and with those already in agricultural engineering work, and to otherwise improve their acquaintance with the field of work for which they are preparing.

Tours to the agricultural engineering building, experimental plots, soybean laboratory, engineering college laboratories, and other points of interest, as well as a special historical plow exhibit, competed for attention during the afternoons.

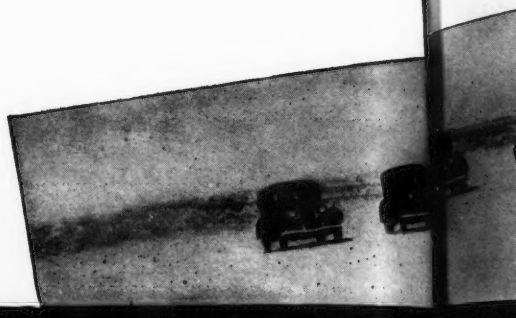
A smoker for the men on Tuesday evening featured a radio broadcast of the championship boxing match of that evening, and provided other entertainment, food, and opportunity for individual contacts.

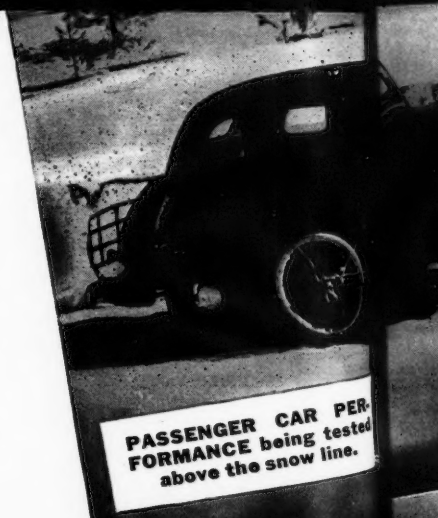
Wives of the local committee members provided ample entertainment for visiting ladies and children. In addition to a reception, luncheons, a garden party at the home of Mr. and Mrs. E. W. Lehmann, tours, and athletics, there were instructive demonstrations on the molding of fancy ice creams, and on arrangement of flowers in the home, given for the ladies by University specialists in these lines.



(Left) C. O. Reed (in white) receiving the Cyrus Hall McCormick Medal from W. G. Kaiser, Chairman of the ASAE Jury of Awards of Honor, as R. U. Blasingame (seated), president of ASAE for 1936-1937, looks on. (Right) Representatives of the Ohio State Student Branch of ASAE present at Urbana to receive the FEI Student Branch Award. They are, left to right, front row, E. A. Silver, faculty adviser, Earl C. Nelson, Stanley M. Elliott, Glenn Foltz, and Myron W. Martin; second row, William Gill, Gordon Royle, and George A. Gearhart

PROVING GROU





IN THE EARLY DAYS automobiles and trucks were tested on roads within a few miles of the factory. Tractors were tested on nearby farms.

Most of the important research questions of today had not yet appeared. The big problem in automobiles and trucks was the development of vehicles which could keep in motion without the assistance of a horse; in tractors, to keep them from getting stuck in the good earth.

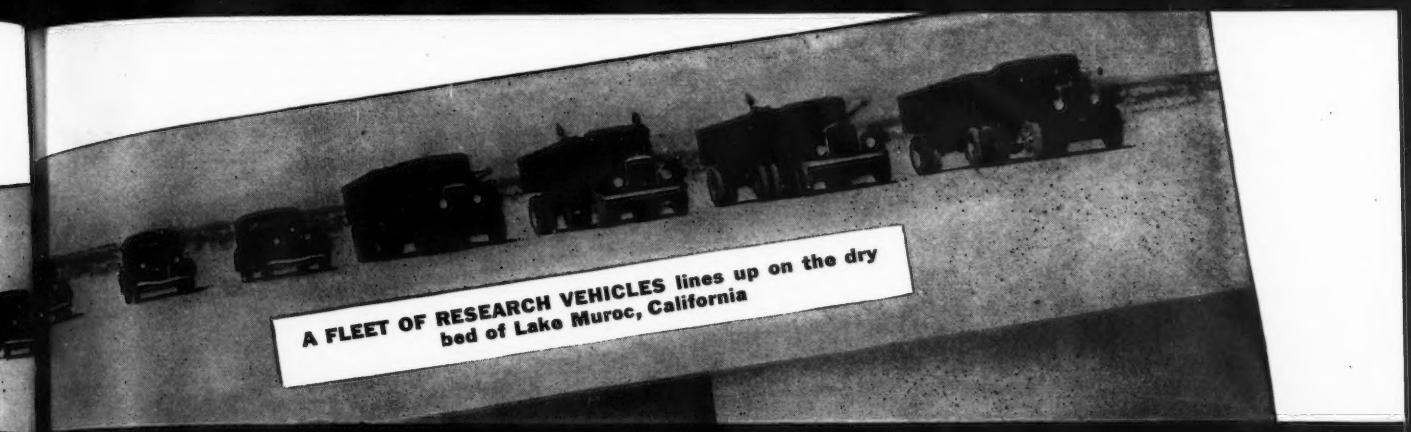
Then, after some years, manufacturers of automobiles and trucks met their need for more comprehensive research with the private proving ground. Here steep grades, unobstructed straightaways and varieties of road surface were built. This new proving ground research resulted in almost unbelievable improvements in durability, comfort and performance.

In a few short years the noisy, jerky contraptions which would climb only the slightest of grades without trouble were replaced by quiet, smoothly-running vehicles which traveled practically any road with ease. The private passenger automobile was generally accepted in nearly all parts of the world.

But as the use of commercial automobiles, trucks and farm tractors increased greatly, they were operated under a constantly growing variety of conditions.

As a result of the wide-spread distribution of automotive equipment of such different types, even the most elaborate proving ground can provide only some of the varied conditions for the research which is necessary to provide improved performance of vehicles in every part of the country at every time of the year. Elevation, atmospheric temperature and humidity, dust storms, snow, ice, and long steep mountain grades establish operating conditions which can not all be satisfactorily reproduced in one place, yet which also create problems that must be solved if automotive progress is to continue. Therefore, the proving ground of the present-day automotive and petroleum research worker may be located practically on the continent of North America, depending on the conditions desired.

The Research Laboratories of the Ethyl Gasoline Corporation, in working for the mutual development of internal combustion engines and their fuels, have established facilities for conducting research work on many different types of equipment under a wide variety of conditions, as is indicated by the accompanying pictures. Many of the investigations are conducted in cooperation with the technical departments of oil and automotive companies, and opportunities for additional cooperative research *will be welcomed*. Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y.



A FLEET OF RESEARCH VEHICLES lines up on the dry bed of Lake Muroc, California

...UND... 1937 model

PER-
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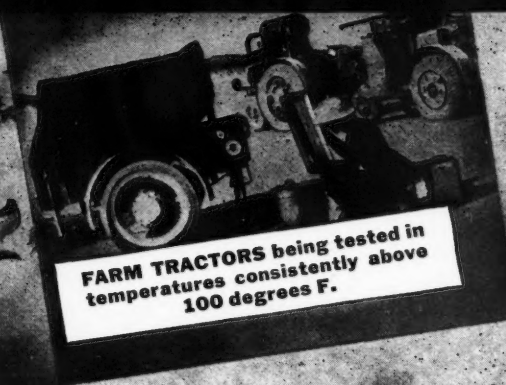


FARM TRACTORS being tested in temperatures consistently above 100 degrees F.

A HEAVY TRUCK runs into an unexpected test on the Mojave desert.

ANALYZING EXHAUST GAS SAMPLES beside a bayonet-spiked Joshua tree.

A GROUP OF EXPERIMENTAL CARS in the mountains.

TESTS IN CITY TRAFFIC are also necessary.

Larger Research Support Sought

CONVINCED that the federal government has not made adequate provision for research in the use of forest products for construction and other purposes in its budget for the fiscal year 1939, the Farm Structures Division of the American Society of Agricultural Engineers at one of its sessions during the annual meeting of the Society at the University of Illinois, June 21 to 24, passed a resolution recommending that Congress increase the amount for such research to an amount equal to that authorized in the McSweeny-McNary Forest Research Act of May 22, 1928. The resolution adopted follows, and it will be quite in order for members of the Society to call it to the attention of their representatives in Congress with a request for support.

WHEREAS one of the major functions of agricultural engineers is to aid farmers in the design and construction of farm homes, barns, and structures for processing and storing of farm products, and

WHEREAS surveys indicate that the majority of farm buildings are in need of renewal or repair which will entail expenditures of billions of dollars, and

WHEREAS wood is both a principal material for the construction and repair of farm buildings and an accessory to other materials now coming into general use in farm building constructions, and

WHEREAS agricultural engineers have need for more adequate scientific knowledge of the properties and use-values of wood with which to meet the exigencies of the farm building problem, and

WHEREAS the federal government has not made adequate provision for research in the satisfactory use of forest products for construction and other purposes, now therefore be it

RESOLVED that in view of these conditions the Farm Structures Division of the American Society of Agricultural Engineers assembled at the annual meeting of the Society at Urbana, Ill., on June 24, 1937, recommends that the Congress of the United States increase in the fiscal year 1939 the sum now devoted to forest products research to an amount equal to the amount authorized in the McSweeny-McNary Forest Research Act of May 22, 1928, and be it further

RESOLVED that the Secretary of this Society be requested to send a copy of this resolution to the Secretary of Agriculture and to have it printed in AGRICULTURAL ENGINEERING.

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

RURAL electrification has increased from virtual stagnation during the depression to the highest peak in history. Without taking into consideration the new distribution lines constructed with federal financing, more new customers were connected to farm power lines in 1936 than in any other year since "electricity started to the country." Plans for 1937 indicate that privately financed lines will exceed 1936 and that the use of electrical energy in rural areas is "on its way."

A large part of the increase in the rural use of electricity is said to be due to the abandonment by utility companies of the practice of requiring farmers and rural industry to contribute to the cost of the lines which serve them. In many areas, distribution lines are being constructed to the consumers' property line without cash or deferred payment for such lines. Another contributing factor to the expansion is reported to be found in reductions in the cost of rural lines.

The Rural Electrification Administration reports that REA lines now equal privately financed lines. A recent summary states that a total of $61,112,110 has been lent or earmarked for 337 specific projects to serve about 200,000 rural customers in 41 states. A majority of the consumers are farmers, but the total includes a great many rural schools, churches, small business establishments in rural areas and country homes. $1,925,000.00 of the total has been allotted for building small generating plants, and $190,000.00 has been borrowed by individuals to finance wiring and plumbing installations.

Plans and specifications prepared by engineers in private practice and approved by the engineering staff of REA are required on all projects, and American Engineering Council is frequently called upon to suggest candidates for engineering positions in Washington and in the states. The compensation either by fee or salary is not always in keeping with that paid by private industry, but the engineering profession is being permitted to make its contribution to public as well as private rural electrification, and the appreciation of the value of engineering knowledge and experience is increasing and spreading to the less populated areas.

* * *

Since AEC committees on flood control, water resources, and other conservation activities have for a number of years recommended consideration of the problems involved according to drainage areas as a whole, the basic idea back of the President's recommendation that the United States be divided into seven regions is in keeping with Council's earlier interpretations of engineers' recommendations. It is also in line with suggestions offered by a number of prominent engineers about a year ago in connection with discussions of the program of the Upstream Engineering Conference.

It is encouraging to observe in the President's recent river conservation message that the protection of the country's water resources is at last receiving authoritative recognition, but it is unfortunate that matters of such vital importance should be confused with other issues. As was to be expected, some elements in Congress are seizing upon the President's message as an opportunity to promote their desire for increased public power development and more federalization. It seems as if they are even willing to sacrifice the real conservation and reclamation values. Others, more moderate in their views, lean toward the establishment of regional planning commissions in accordance with the President's recommendations. In this difference of ideas is to be found a most vital issue in the future social and economic life of our country.

The experience of recent years shows that we know too little about rivers for any comprehensive planning on such a scale without much study and more data. Engineers on Council's committees feel that we have not yet learned enough about regional planning to undertake the development and conservation planning for the scores of streams involved in the seven proposed authorities. It is true that the National Resources Committee has only recently completed a drainage basin survey, but the very engineers who made that survey say that it is only a preliminary for a further investigation.

Realizing that we face urgent problems of conservation, of water allocation, of purification, of floods, of water supply, and in a lesser degree power and navigation; it is believed that the most practical approach to these problems may be made through boards set up to deal with each river basin as a whole. A board of local membership should be able to accomplish useful results at an early date. Its work could be coordinated with regional activities and given business-like attention.

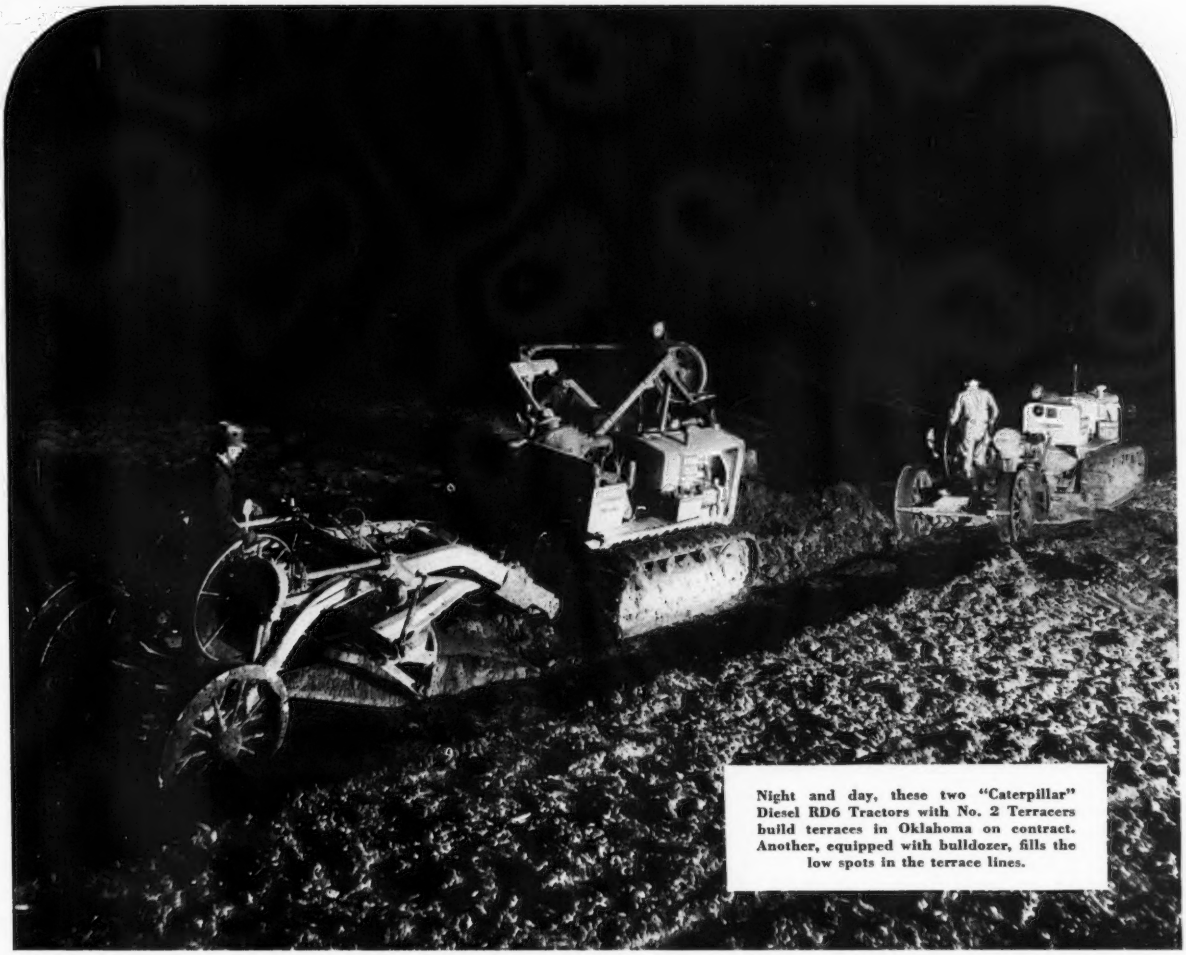
Council's committee on the conservation and utilization of natural resources is giving this entire problem serious consideration. The committee is seeking all available engineering opinion and factual evidence regarding the need for more hydrological and unique data, and is endeavoring to determine the extent to which regions have come to think in common. At the moment, however, it seems to be best to leave control and regulation out of the planning for river valleys and devote more time and thought to education.

* * *

A "map consciousness" has been carried to the White House and to Congress, but it has not yet become sufficiently important in the several states and communities to command the serious consideration of those who are in a position to inaugurate a comprehensive mapping program. Council's staff, the AEC committee on surveys and maps program, the Division of Surveying and Mapping of ASCE and many of those who recognize the fundamental need for accurate maps and appreciate the economic value of such basic data to the public, have done almost everything *except* lobby for substantial mapping appropriations.

The President, the Congress, departmental secretaries, bureau chiefs and most officials and representatives of the people are responsive to factual presentation and they are being kept informed, but obviously a demand from "the constituency" for maps for both immediate and future use is essential to favorable legislative action. It is not enough to have engineers, planners, geologists and other scientific and constructive minds in favor of making surveys and preparing basic maps of the terrain of the United States. The people themselves must insist upon having maps for public works and private enterprise.

A number of federal government agencies, other than USC&GS and USGS are making "special purpose" maps. Most of them are good maps, but they are not basic and many of them cannot be fitted into a nation-wide basic mapping program. It is reported that the Soil Conservation Service, for example, is to do some 350,000 square miles of aerial mapping in 1937 and 1938. No one has any doubt about the usefulness of such maps to all parties interested in soil conservation, but it is not expected that they can be *(Continued on page 326)*



Night and day, these two "Caterpillar" Diesel RD6 Tractors with No. 2 Terracers build terraces in Oklahoma on contract. Another, equipped with bulldozer, fills the low spots in the terrace lines.

TERRACING BECOMES A BUSINESS!

NIGHT and day, the earth rolls from the stout blades of Butler Brothers' "Caterpillar" No. 2 Terracers. Month after month, the large savings of their "Caterpillar" Diesel RD6 Tractors keep piling up!

These Terracing Contractors, operating near Oklahoma City, are making money building terraces *at so low a price per mile that farmers are glad to hire the job done.*

The success of Terracing Contractors, with teamed "Caterpillar" Outfits, points to a way that farmers — by communities, districts and States — can get their land terraced. One Contractor has already built more than 2500 miles of terraces!

To the young agricultural engineer, contract terracing offers a useful business in an uncrowded field — a business aggressively promoted by local, State and Federal agencies — a business for which there is a proven "Caterpillar" Outfit of the size to fit his ambitions!

Terracing has become a business!

NEW IN THE LINE — THE NO. 22 TERRACER! Here is the New "Caterpillar" No. 22 Terracer — a size between the Famous No. 1 and No. 2. Built to operate with the Twenty-Two or Diesel RD4 Tractor.

CATERPILLAR TRACTOR CO.
PEORIA, ILL.

REG. U.S. PAT. OFF.

WORLD'S LARGEST MANUFACTURER OF DIESEL ENGINES, TRACK-TYPE TRACTORS AND TERRACERS

Washington News Letter

(Continued from page 324)

used by either the Coast and Geodetic Survey on triangulation or by the U. S. Geological Survey for reckoning topography.

Engineers who have made a lifelong study of map-making and map uses agree that if the triangulation and topography of the country were established on verified maps which were accurately related, it would not be necessary to make so many maps for special purposes. They also agree that the cost of making special maps, when actually needed, would be greatly reduced by having basic triangulation and topography as a foundation. In other words, it would be real economy to have this basic data for the guidance of all enterprise concerned with the earth's surface within the United States.

Such are the simple facts which engineers may impart to their neighbors, business associates and legislative representatives. They may also say, without fear of contradiction, that the Army needs more of this basic information around our frontier to strengthen national defense. The Forest Service, Reclamation Service, Soil Conservation Service—all of those interested in regional conservation activities and innumerable private projects are constantly faced with need for better maps than are available, and find from actual experience that much more could be saved by having adequate maps than the entire cost would be.

* * *

Engineers who have interested themselves in the proposals made by the Administration and members of Congress to reorganize the surface of the United States into seven conservation and utilization authorities may be interested in the following excerpts from recent reports of the national resources committee:

"Prepared under the supervision of the Water Resources Committee of the National Resources Committee, the present report, 'Drainage Basin Problems and Programs,' describes the principal water problems of each of the drainage basins and presents specific recommendations for construction and investigation projects with priorities of importance and time. The report was prepared with the active cooperation of State and Regional Planning Boards and of Federal Agencies. Three principal aspects emphasized in connection with the program are:

1 That the report does not suggest any particular rate of public construction expenditure. It suggests an orderly integrated plan of construction and investigation, which may be carried out over a period of years.

2 That the listing of projects having local interest primarily does not indicate that Federal funds should be used for their construction. The listing means only that the project is believed to fit into an integrated drainage basin program.

3 That the National Resources Committee will not be responsible for carrying out any of the recommended work; it is not an administrative agency. The work suggested, if carried out, will be through the normal channels of existing Federal, state, and local agencies. The report is based on an intensive study by a special organization established by the Water Resources Committee, which worked in close cooperation with State Planning Boards as well as with all Federal agencies concerned with water problems."

Projects are classified into the following groups; Group A is ready for construction and should be undertaken as soon as possible. Group B, while desirable, can have priority definitely determined only after additional studies. Group C should follow Group B in sequence. The estimated cost of the project in Group A is $1,727,000,000, in Group B, $1,034,000,000 and in Group C, $1,400,000,000.

An interesting comparison may be had by noting that the annual federal expenditure for construction involving water use and control in the period from 1920 to 1929 range from 30 to 63 million dollars and only increased to 78 million in 1929 whereas they had reached a figure of 374 million dollars by 1935. It would, therefore, seem that the proposed reservoir of projects in Groups A, B, and C for a period of years for both Federal and non-Federal undertakings in the field of water control and use, which would be left subject to review and control in the future, is more consistent with the normal rate of expenditures for such purposes in this country.

* * *

One of the objectives of the World Power Conference is the preparation of inventories of the resources of the world in fuel and power. The first inventory entitled "Statistical Yearbook of the World Power Conference," now ready for distribution, represents an excellent attempt to compile and publish international statistics of power resources, development, and utilization upon a comprehensive and comparable basis. Some of the information has not been published before in any country.

Necrology

HAROLD BLAKE DINNEEN, 53, vice-president and director of the Minneapolis-Moline Power Implement Company, passed away at his home in Minneapolis on June 9. Until the time of his sickness early in 1936, he was the officer in charge of the engineering and design departments.

Mr. Dinneen was born in Albany, Illinois, October 30, 1883. He spent most of his life in the farm machinery business. He started as a clerk in the purchasing department of Deere & Company, Moline, Illinois, in 1904. In all, he spent 16 years with Deere & Company, going from the purchasing department through the sales department and through the experimental department. He was manager of the plow works from 1913 to 1920.

On January 1, 1920, he went with the Moline Plow Company as vice-president and production manager. In this capacity he served the Moline Plow Company until its liquidation in 1925. Early in 1925, he and some associates formed the Moline Implement Company and he was the vice-president in charge of production.

In 1929, when the Minneapolis-Moline Power Implement Company was formed, Mr. Dinneen was made a vice-president and director of the new company. He served in this capacity until the time of his death.

Mr. Dinneen is survived by his wife, Frederica; his mother, Mrs. J. W. Dinneen; and his daughter, Mary Jane—all residing in Minneapolis, Minnesota; another daughter, Mrs. Ralph Stewart Knapp of Chicago; a granddaughter, and a brother, Arthur L. Dinneen, of Rockford, Illinois.

Funeral services were held in Moline on June 11th.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

John G. Bamesberger, chief agricultural engineer, Region 10, Soil Conservation Service, U. S. Department of Agriculture. (Mail) City Hall, Santa Paula, Calif.

S. A. Braley, fellow, Mellon Institute, Pittsburgh, Pa.

Herold F. Bruns, farm agent, Toledo Edison Company (Defiance Division). (Mail) RFD No. 2, Defiance, Ohio.

John R. Costello, assistant sales manager, John Deere Plow Company. (Mail) Box 7, Vacaville, Calif.

Kyle Engler, instructor, agricultural engineering department, Iowa State College, Ames, Iowa.

Paul K. Fanning, Melvern, Kansas.

Edward J. Fisher, northwestern district manager, National Lumber Manufacturers Ass'n. (Mail) 1115 Lumber Exchange Bldg., Minneapolis, Minn.

Loring O. Hanson, farm representative, Portland Cement Ass'n. (Mail) 1215 Chandler St., Madison, Wis.

C. J. Hurd, associate agricultural engineer, Tennessee Valley Authority. (Mail) 2765 Kingston Pike, Knoxville, Tenn.

Robert S. Hursh, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 283, Leon, Iowa.

Andrew Hustrulid, assistant professor, agricultural engineering department, University of Minnesota, St. Paul, Minn.

Andrew J. Longley, assistant agricultural engineer, Region 6, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 836 Crockett St., Amarillo, Tex.

Charles K. Otis, instructor, agricultural engineering department, Kansas State College, Manhattan, Kans.

R. C. Proctor, salesman, Starline Inc. (Mail) Box 67, Oxford, Mass.

Ralph L. Ricketts, assistant engineering aide, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) CCC Camp D-3-Mo., Delta, Mo.

Cecil A. Root, sales supervisor, Northwestern Electric Company, 614 Main St., Vancouver, Wash.

H. W. Schaffner, engineering aide, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Camp D-6-Mo., Rockport, Mo.

John N. Shellabarger, engineering aide—agricultural—Soil Conservation Service, U.S. Department of Agriculture. (Mail) Box 165, Newberg, Ore.

E. Stanley Shepardson, extension instructor, agricultural engineering department, Cornell University, Ithaca, N. Y.

James L. Shepherd, University of Georgia, Athens, Ga.

William F. Strouse, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 315 Hancock Ave., Vandergrift, Pa.

C. W. Veach, agricultural engineering department, University of Illinois. (Mail) 1111 S. Arbor, Champaign, Ill.

C. A. Walt, truck and tractor tire trade sales department, Firestone Tire & Rubber Co., Akron, Ohio.

L. C. Watson, camp engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 228 Somers St., Eaton, Ohio.

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Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

DRILLING FINE LIMESTONE FOR LEGUMES, *W. A. Albrecht.* Missouri Sta. Bul. 367 (1936), pp. 20, figs. 13. The methods and advantages of drilling finely ground limestone for legumes are set forth in detail. Limestone, according to research at the station, supplies calcium as a nutrient as well as for correction of soil acidity. The requirement of finely ground (about 40-mesh) material and possible use of other forms of calcium and the greater effectiveness of smaller quantities drilled compared with broadcasting are pointed out. Fine limestone can be drilled with the fertilizer attachment of the grain drill when legumes are planted in the spring or with wheat or other nurse crop in autumn. Drilling limestone for each legume crop in the rotation is advised. Limestone alone does not guarantee clover stands, and its use emphasizes other deficiencies in soil fertility. Many soil types are mentioned as responding to fine limestone treatment. In cost of limestone, drilling 0.25 ton of finer limestone costs less than broadcasting 2 tons of 10-mesh material per acre, and drilling also effects a substantial saving in labor.

DECAY IN STRUCTURAL TIMBERS, *E. A. Rudge and H. Lewis.* Jour. Soc. Chem. Indus., Trans., 54 (1935), No. 46, pp. 385T-387T, fig. 1. In studies of dry rot in a skirting board removed from a modern dwelling house, it was concluded that the extent of decay, as evaluated by chemical methods, is dependent upon the amount of iron and calcium compounds filtering into the tissue. The opinion is expressed that fungus growth cannot be held responsible for the full extent of chemical breakdown, and this example is considered representative of the majority of instances of similar decay.

The results indicate that careful attention should be given to the damp coursing in structures where timber is to be employed in order to remove the source of ions concerned in inorganic decay. Unprotected wood should not be fixed to lime-plaster surfaces, since these, under suitable conditions, are conducive to the formation of the inorganic ions concerned in the decay.

The prevalent system of fixing timbering to wooden plugs by means of iron nails is to be deprecated, since it is shown that this method provides a favorable route for infiltration and a potential source of iron compounds. The well-recognized harmful effect of iron, which may be due to a process of catalytic oxidation, should be avoided by the use of copper or galvanized nails.

THE TWO-ROW CULTIVATOR CONVERTED INTO A WEED CONTROL MACHINE, *D. E. Wiant and R. L. Patty.* South Dakota Sta. Bul. 303 (1936), pp. 8, figs. 7. It is pointed out that the two-row cultivator can be converted easily and quickly into a weed control machine, which is satisfactory both for weed control or summer fallowing.

It has been found that the type of cultivator which lends itself best to this conversion is the two-row, shovel type, horse-drawn cultivator. Practical information is given on the manner of making this conversion most satisfactorily.

MACHINE PLACEMENT OF FERTILIZERS FOR SNAP BEANS IN FLORIDA, *G. A. Cumings, A. L. Sharp, J. J. Skinner, G. M. Bahrt, and G. H. Serviss.* U. S. Dept. Agr. Circ., 399 (1936), pp. 43, figs. 20. This report presents the results of studies conducted cooperatively by the Bureaus of Agricultural Engineering and Plant Industry.

Ten fertilizer placement experiments with snap beans were conducted on Leon fine sand and St. John's fine sand near Winter Garden, Fla., in 1931, 1932, and 1933. Three fertilizers were used in the placement experiments. Two of these contained 5 per cent af ammonia, 7 per cent of phosphoric acid, and 5 per cent of potash, and one contained twice the amount of these fertilizer constituents. One of the 5-7-5 fertilizers contained only inorganic nitrogen and the other contained nitrogen one-half from inorganic and one-half from organic sources.

Fertilizers placed in 3.5-in bands on the surface of the ground over the seed, mixed with the soil under the seed, or placed in bands 1.75 and 3.5-in wide 1 in under the seed materially delayed germination and reduced the final stand of plants under normal rainfall conditions. Fertilizers placed on the surface of the soil injured the young seedlings as they emerged.

Fertilizer placed in bands 2 or 4 in to one or both sides of the seed row 1.5 in below the level of the seed, and 1.75 or 3.5-in bands 3 in under the seed, stimulated germination and plant growth sufficiently to give a final stand of plants superior to and larger than those of plants unfertilized at time of planting.

Effective rainfall immediately following planting reduced adverse effects on germination of placements under the seed, but intensified injurious effects of the placement over the seed. Lack of rainfall during the germination period intensified the adverse effects of placements under the seed. Material delay of germination and injury to stand was reflected in plant growth and yield.

Earliest germination, best stands, and most rapid growth of plants, and earliest maturity, and highest yields of green beans both at the first picking and total, were obtained with fertilizer placements in a band 3 in under the seed, and in a narrow band 2 in to each side of the seed row 1.5 in below the level of the seed. The yields at first picking were slightly higher and the total yields slightly lower for the side placement.

Lower efficiency of the fertilizer as indicated by yields resulted from the placements 4 in to the sides of the seed row, mixed in the surface soil of the seed row, and application 1 week after planting.

The three fertilizers used, in general, gave about the same relative result from various comparable placements. The 10-14-10 fertilizer and the 5-7-5 fertilizer that contained nitrogen equally from inorganic and organic sources were slightly inferior to fertilizer 5-7-5 containing only inorganic nitrogen, when placed in the most favorable positions with respect to the seed.

In obtaining the two most advantageous placements, namely, 3 in under the seed, and 2 in to each side of the seed row, the latter was found the more practical with respect to machine operating difficulties resulting from draft and from vegetation previously plowed under.

REPRESENTING THE DISTRIBUTION OF GROUND STRESSES, *K. Fischer.* ASTM [Amer. Soc. Testing Materials] Bul. 81 (1936), pp. 12, 13, figs. 6. This is a brief description of a method recently developed in Austria that enables representation of the distribution of stress in homogeneous masses of sand in a simple manner. The results have application to all soil dynamics work.

COMMERCIAL ASPECTS OF ELECTRO-HORTICULTURE, *J. Cooper.* Rural Electrif. and Electro-Farming, 12 (1936), No. 136, pp. 66-68, figs. 5. This paper deals briefly with irradiation of plants and soil heating, with particular reference to their commercial aspects. These two practices are considered to be a success in England.

CANADIAN WOODS: THEIR PROPERTIES AND USES, *T. A. McElhanney, et al.* Ottawa: Canada Dept. Int., For. Serv., 1935, pp. XV + 345, figs. [133]. This book contains data with respect to the properties and uses of Canadian woods required by those directly engaged in the wood-using industries.

FOREST SERVICE OFFERS 2-STORY PLYWOOD PANEL HOUSE, *R. F. Luxford and A. Smerda, Jr.* Amer. Builder and Bldg. Age, 58 (1936), No. 8, pp. 51-53, figs. 10. In a brief contribution from the USDA Forest Service, an experimental prefabricated house is described in which plywood is the principal material of construction.

RUBBER AS A PROTECTIVE DEVICE ON CONCAVE TEETH FOR THRESHING SEED BEANS, *B. L. Wade and W. J. Zaumeyer.* Jour. Amer. Soc. Agron., 28 (1936), No. 9, pp. 723-726. Investigations conducted by the USDA Bureau of Plant Industry are briefly reported.

The results, which are based on only two seasons' work and two varieties of beans, indicate that in some cases rubber on the concave teeth may give some slight protection, but probably not enough to justify the expenditure of time necessary to equip the thresher. It is deemed more important to control the cylinder speed of the machine, as well as the distance through which the beans drop after leaving the cylinders, and also the hardness of the surface upon which they drop. *(Continued on page 330)*

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Agricultural Engineering Digest

(Continued from page 328)

FENCING WITH ELECTRICITY, *E. W. Lehmann.* Successful Farming, 34 (1936), No. 8, pp. 22, 32, fig. 1. In a brief contribution from the Illinois Experiment Station, practical experience in the use of electrical fencing is described.

TERRACES TO SAVE THE SOIL, *E. W. Lehmann and R. C. Hay.* Illinois Sta. Circ. 459 (1936), pp. 31, figs. 24. Practical information is presented on the design and construction of terraces for the control of soil erosion in Illinois.

PLAIN CONCRETE, *E. E. Bauer.* New York and London: McGraw-Hill Book Co., 1936, 2. ed., pp. XIII+364, pl. 1, figs. 147. This is the second edition of this book, in which nearly all the material has been rewritten and many new illustrations added.

The information presented on special cements has been enlarged to include the recent developments and increased knowledge of the action of cement in the setting and hardening processes. The theories of proportioning are presented in a separate chapter and illustrative procedures have been included. The chapter on estimating has been rewritten and incorporated as a chapter on applied proportioning immediately following the one on theories. In this chapter are included new curves showing for present-day cements the relationship between strength and (1) water-cement ratio, (2) cement-space ratio, and (3) cement-water ratio. A complete set of computations illustrating the figuring of quantities of materials for making concrete are shown. In the chapter on the factors affecting concrete strengths, new curves for present-day cements have been given for age-strength relationship for standard cements and a special cement. Results of recent tests of the effect of low temperatures are also given. Available data on the effect of vibration of concrete are given in the chapter on placing, finishing, and curing of concrete. A section on durability is included in the chapter with workability and waterproofing. Specifications of the American Society for Testing Materials for ready-mixed concrete and for concrete for pavements are quoted in full. Instructions for the performance of the various tests have been revised to include the latest revisions of the ASTM. Readers desiring to investigate any phase of the subject will find many references to source material.

LAYING OUT FIELDS FOR TRACTOR PLOWING, *C. D. Kinsman and L. A. Reynoldson,* rev. by *A. H. Glaves.* U. S. Dept. Agr., Farmers' Bul. 1045, rev. (1936), pp. [2] + 18, figs. 16. This bulletin briefly describes the more common methods recommended by farmers who use tractors for plowing. It is a revision of a former bulletin.

GEOPHYSICAL PROSPECTING FOR UNDERGROUND WATERS IN DESERT AREAS, *F. W. Lee.* U. S. Dept. Int., Bur. Mines, Inform. Circ., 1936, I. C. 6899, pp. 27, figs. 27. The purpose of this paper is to describe methods and results of geophysical prospecting for water in Nevada and adjacent states. Discussions also are included of some of the associated problems relating to field technic and geologic interpretations.

The conclusion is drawn that geophysical surveys in Nevada can be used to determine the underground water reserves. It appears that sufficient differences exist in electrical conductivity between the gravel and clay beds to permit successful prospecting for water, especially at shallow depths where the water-bearing beds are as much as 350 ft deep. Possible productive territory can be delineated and barren districts excluded.

It was found that considerable increase in speed of field measurements as well as in interpretation is possible with the newer earth-resistivity measuring instruments.

MEASURING APPARATUS FOR THE TESTING OF AGRICULTURAL MACHINERY USED BY THE MONTANA AGRICULTURAL EXPERIMENT STATION, *H. E. Murdock.* 2. Cong. Internatl. Genie Rural Madrid, 1935, Organ. et Raps., pp. 275-284, figs. 13; Fr. abs., p. 284. In a brief contribution from the station this equipment is described and illustrated.

DETERMINING THE PERCENTAGE OF MOISTURE IN SOIL SAMPLES WITHOUT DRYING, *E. E. Bauer.* ASTM [Amer. Soc. Testing Materials] Bul. 81 (1936), pp. 10, 11, 13, figs. 2. This paper is a report of efforts made at the University of Illinois to adapt procedure for the determination of the constituents of freshly made concrete to the determination of the moisture content of soils. The paper explains briefly the theory involved, describes the equipment and test procedure used, and gives the results of tests and check tests of oven-dried samples.

ELECTROLYTIC MEASUREMENT OF THE CORROSIVENESS OF SOILS, *I. A. Denison.* Jour. Res. Natl. Bur. Standards [U. S.], 17 (1936), No. 3, pp. 363-387, figs. 12. The electrolytic behavior of steel in contact with 47 soils of known corrosiveness was studied by means of a cell in which both electrodes were steel and the electrolyte was moist soil. By providing differential aeration of the electrodes the cell was enabled to develop its own electromotive force. Measurements were made of the voltage, current, and resistance of such cells. The relation between the current density and applied voltage was also studied. The losses in weight of the test specimens were related to the average current density over a certain range of applied voltage and to the total quantity of electricity produced in the corrosion process. The corrosion of the specimens in the laboratory tests was correlated with corrosion experienced in long-time field tests. The results of the tests may be applied practically in predicting the corrosiveness of soils toward iron and steel. However, they cannot be applied to the prediction of leaks or to the estimation of the useful life of a section of pipe line until the relations connecting depth of pitting with exposed area and time can be established.

TESTS OF FARM TRACTORS UNDER FIELD CONDITIONS, *H. E. Murdock.* 2. Cong. Internal. Genie Rural. Madrid, 1935, Organ. et Raps., pp. 287-294, figs. 7; Fr. abs., pp. 293, 294. In a brief contribution from the Montana Experiment Station, results of seven seasons of tests of farm tractors under field conditions are briefly summarized. These have related particularly to the effect of useful drawbar horsepower on fuel consumption, use of distillate, effect of carburetor setting, effect of gear on fuel consumption, and effect of drawbar pull on speed and power.

Data are presented to show that the fuel consumption per hour of a gasoline tractor varies directly with the horsepower, and that the fuel consumption per horsepower hour decreases with the power. Data on the use of distillate showed that the fuel consumption is practically the same as with gasoline.

It was found that drawbar pull has more effect on slip of drivewheels than any other factor.

A RESUME OF COMPARATIVE STUDIES OF LOW PRESSURE PNEUMATIC TIRES FOR FARM TRACTORS AND FARM EQUIPMENT IN THE UNITED STATES, *G. W. McCuen and E. A. Silver.* 2. Cong. Internal. Genie Rural, Madrid, 1935, Organ. et Raps., pp. 240-264, figs. 21; Fr. abs., pp. 263, 264. In this contribution from the Ohio Experiment Station, experience at 12 other experiment stations on the use of low-pressure pneumatic tires on farm tractors is reviewed and the results of experiments at the Ohio Station are presented.

It was found that a tractor equipped with low-pressure pneumatic tires has a lower rolling resistance than one equipped with steel wheels and lugs. The fuel consumption of a tractor with low-pressure pneumatic tires is less than one equipped with steel wheels and lugs at the same relative drawbar pull. Under most conditions rubber-tired equipment on tractors is very satisfactory for plowing or for other farm operations. Rubber tires on tractors are ineffective where moist barnyard manure has been spread over the ground. Under favorable conditions, rubber-tired equipment will transmit a greater drawbar horsepower than steel equipment in second or third gears. Rubber equipment makes it possible to use the tractor for many jobs which could not be done with steel wheel equipment. The tread of rubber tires does not pick or fill up with surface trash like steel wheels and lugs. Rubber-tired equipment permits higher speeds, which generally result in greater fuel economy. Less dust is stirred up by the rubber tires on dry surfaces. With 1,349 hr of use there has been no evidence of excessive wear on the tires. During that time only two punctures were experienced. Under most conditions a tractor equipped with rubber tires is more comfortable for the operator to ride. The elimination of severe shocks and impacts should give the tractor a much longer life.

On all rough and soft tractive surfaces the low-pressure rubber tires on wagons required the least draft, on smooth, hard surfaces, the steel wheel required the least draft, and on cultivated soil or meadow the rubber tire will not "cut in" as deeply as the steel wheel. Rubber tires will not damage meadows as badly as will steel wheels. The width of rim of steel wheels is a factor only in cultivated soil, with the wider rim usually having the advantage in draft. A narrow wheel track usually fills in after the wheel has cut through, making it necessary for the rear wheels to cut a new track. The roller type of bearing required much less draft than the plain or skein type of bearing. On a cinder road the least draft was recorded at a speed of approximately 8 miles per hour for rubber-tired equipment on wagons. Above that speed the draft increased rapidly. A corn picker equipped with rubber tires required much less draft than the same picker equipped with steel wheels. Much less surface trash was picked up by the rubber tires.

(Continued on page 332)

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IMPROVEMENT OF FARM MACHINES, *J. B. Davidson.* 2. Cong. Internal. Genie Rural, Madrid, 1935, Organ. et Raps., pp. 365-372, fig. 1; Fr. abs., p. 372. This presents the results of an investigation of the status of 25 farm machines in general use and manufactured during the period 1910-14, as compared with that of similar machines manufactured in 1932. The quality index number of farm machines in 1932 as compared with farm machines in 1910-14 varied from 130 to 215.

AIR CONDITIONING AND ENGINEERING. Detroit: Amer. Blower Corp., 1935, Sect. I, pp. 1-359, figs. 275. This is a treatise of the technique of conditioning and mechanical movement of air for the health and comfort of human beings. It contains chapters on air, heat and steam, air flow, air ducts, fans, power selection for fan drive, sound, ventilation, heating, unit heat and unit ventilators, humidifying, cooling and dehumidifying, refrigeration, temperature and humidity control, vapor absorption and removal, drying, ceramics, furnaces, mechanical draft, fume collection and removal, dust collection and pneumatic conveying, mine ventilation, and tables and conversion factors.

IRRIGATION INVESTIGATIONS BY THE NEVADA STATION, *J. E. Church, C. Elges, and G. Hardman.* Nevada Sta. Rpt. 1935, pp. 18, 19, 22, 23. The progress results are briefly presented of studies of timber and snow and snow surveying, forecasting the runoff of the Humboldt River, reclamation of certain desert soils under irrigation from artesian wells in the Las Vegas Valley of southern Nevada, and on agricultural land and water resources of the basins of the Truckee, Carson, and Humboldt Rivers and minor streams.

THE PHYSICAL PROPERTIES OF CLAY SOILS AND SOME ASPECTS OF THEIR MECHANICAL BEHAVIOR, *L. F. Cooling.* Jour. Soc. Chem. Indus., Trans., 55 (1936), No. 2, pp. 25-31, figs. 7. The dynamic properties of clay soils are discussed, with particular reference to their use in road building and as foundations for buildings. Special attention is devoted to the properties of compressibility, resistance to lateral movement, and influence of structure.

THE SELECTION, PRESERVATION, DISTRIBUTION, AND IDENTIFICATION OF AUSTRALIAN POLE TIMBERS, *J. E. Cummins and H. E. Dadswell.* Austral. Council Sci. and Indus. Res. Pam., 55 (1935), pp. 79, pls. 7. This technical paper gives the results of a recent survey of present practices of users of poles in Australia, and invludes statistics on the number, size, classes, average cost, renewals, and annual extensions of poles throughout Australia. The various factors, such as termites and decay, affecting the life of poles, and those features likely to occur in a pole and which may affect its service life, are discussed, and a description of the most important methods of pole preservation and their probable relative economy are given. In order to assist pole users, a general description of the timbers used for poles and of their distribution and keys for their identification are included.

MANAGEMENT AND USE OF AGRICULTURAL LANDS INCLUDING FARM WOODS AND PASTURES, *H. H. Bennett.* U. S. Dept. Agr., Soil Conserv. Serv., 1936, SCS-MP-13, pp. 39, pls. 10. This paper, which was presented at the Upstream Engineering Conference, deals with the subject from the standpoint of soil conservation and erosion control, with special reference to its mechanical features.

BIBLIOGRAPHY ON SOIL CONSERVATION, compiled by *L. H. Wieland,* rev. by *J. Henderson.* U. S. Dept. Agr., Soil Conserv. Serv., rev., 1936, SCS-MP-10, pp. [V] + 179. This is the first revision of this bibliography.

THE ARREST AND PREVENTION OF DEVASTATION BY FLOODS, *G. L. Fuller and H. M. Eakin.* U. S. Dept. Agr., Soil Conserv. Serv., 1936, SCS-MP-12, pp. 11. A detailed discussion is given of the subject, which was presented before the Connecticut Engineering Congress.

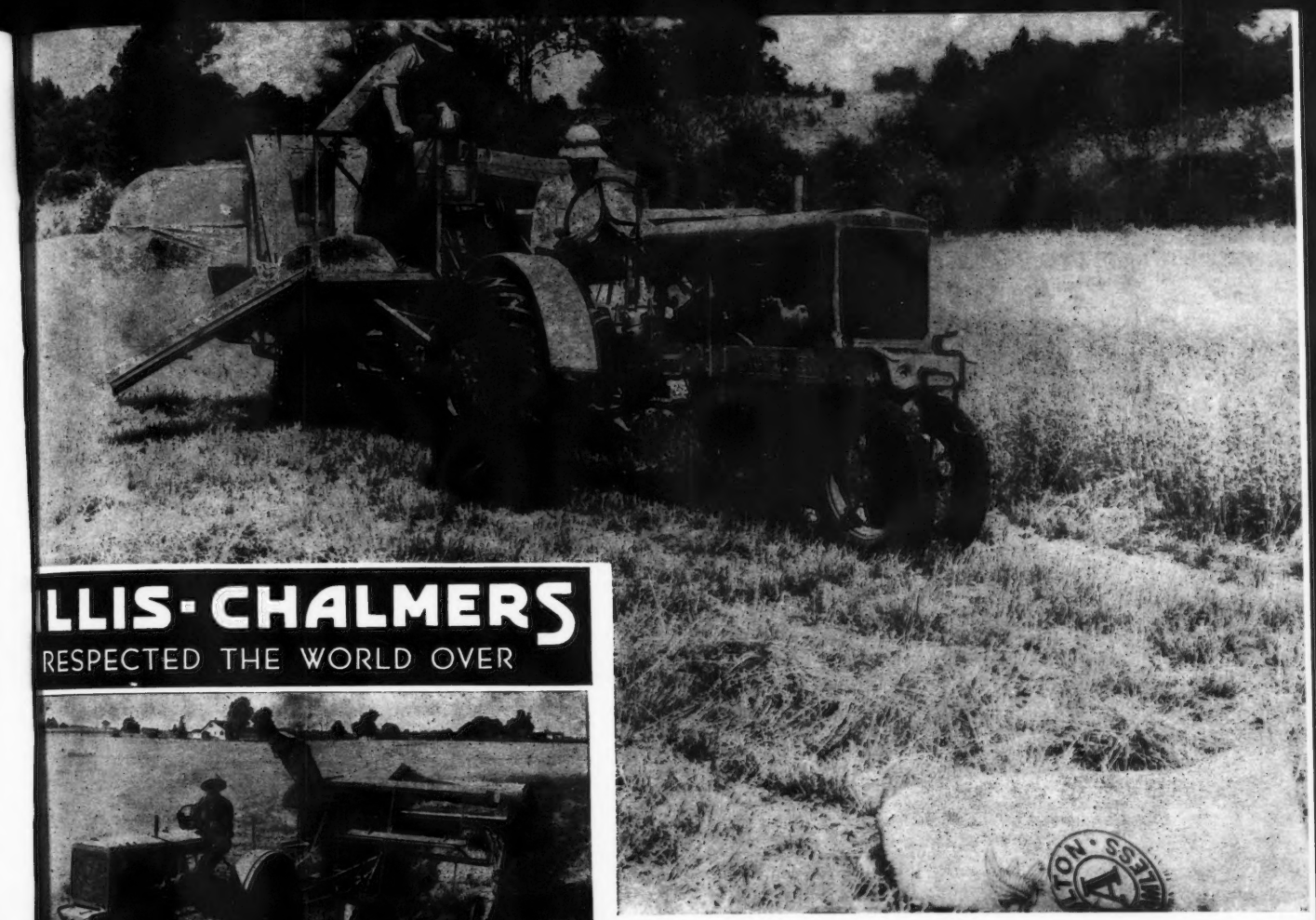
INSTRUCTIONS FOR RESERVOIR SEDIMENTATION SURVEYS, *H. M. Eakin,* rev. by *G. C. Dobson and C. B. Brown.* U. S. Dept. Agr., Soil Conserv. Serv., rev., 1936, SCS-SS-2, pp. [1] + 36 fig. 1. The text of these instructions is presented in detail. It includes sections on general plan of survey; choice of reservoirs; choice of survey methods; range method; contour method; further computations; note keeping, survey monuments; preparation of final reports; and preparation of maps, illustrations, and supplemental material.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING, June. 22 to 26, 1936. Cambridge, Mass.: Harvard Univ., 1936, vol. 2, pp. 318 + [24], figs. [536]. This is an extensive publication relating primarily to the engineering features of soil dynamics as they are being investigated in soil mechanics laboratories all over the United States and in many European countries. Numerous reports describing the procedure followed in these laboratories are included, and certain special papers of particular significance are presented on The Influence of Scale-like Shape of Clay Particles on the Process of Shear in Soils, by G. Ter-Stepanian (pp. 112-116); The Influence of the Speed of Loading Increment on the Pressure Void Ratio Diagram of Undisturbed Soil Samples, by K. Langer (pp. 116-120); Shearing Tests, Compressive Tests on Cylinders, Comparison of Results in View of Determining the Angle of Friction and the Settlements in Soils, by M. Buisson (pp. 121-125); A Ring Shearing Apparatus for the Determination of the Shearing Resistance and Plastic Flow of Soils, by M. J. Hvorslev (pp. 125-129); An Investigation of Jurgensen's Squeeze Test, by A. Warlam (pp. 129-133); Progress Report on an Investigation of the Shearing Resistance of Cohesionless Soils, by J. D. Parsons (pp. 133-138); Progress Report on Research on the Consolidation of Fine-Grained Soils, by H. Gray (pp. 138-141); A Rational Method for the Determination of the Vertical Normal Stresses Under Foundations, by W. Steinbrenner (pp. 142, 143); A Method of Representing the Distribution of Stress in Ground, by C. Fischer (p. 144); Influence of Rigidity of a Circular Foundation Slab on the Distribution of Pressures over the Contact Surface, by H. Borowicka (pp. 144-149); The Measurement of Soil Pressures on the Lining of the Midtown Hudson Tunnel, by G. M. Rapp and A. H. Baker (pp. 150-156); Stress Distribution in Elastic Solids, by H. Gray (pp. 157-168); Correlation of Surface Loading Tests With Unconfined Compression Tests for Cohesive Soils, by A. B. Mason (pp. 169-173); Settlement Records and Loading Data for Various Buildings Erected by the Public Works Department, Municipal Council, Shanghai, by N. W. B. Clarke and J. B. Watson (pp. 174-185); Foundation Data, by J. A. Favret (pp. 185, 186); Foundation Soil Testing and Settlement Measuring, by C. Fischer (pp. 186-191); Securing a Vienna Tenement House Against Injurious Settlement by Reducing the Soil Pressure and Draining the Underground, by R. Tillmann (pp. 191-193); The Stability of Foundations of Embankments, by L. Jurgenson (pp. 194-200); Stability of Earth Slopes, by J. Jaky (pp. 200-207); Conditions for the Stability of Piles, by B. M. Lozovsky (pp. 208-211); Dynamic Formula for Determining the Resistance of Piles, by B. M. Lozovsky (pp. 212-216); Notes on the Pile Driving Formula Included in the Proposed Boston Building Code, by J. S. Crandall (pp. 216-220); Pile-Driving and Test-Loading Records, by N. W. B. Clarke and J. B. Watson (pp. 221-227); Load Test on a Wood Pile Driven Into the Ground, by R. Tillmann (pp. 227-229); Relation Between Relative Density and Earth Pressure, by H. Petermann (pp. 254, 255); Observation of the Texas State Highway Department on the Subsequent Effects of the Uniformity and the Non-uniformity of Foundation Soil-Types on Pavements and Also the Effects of Uniformity and Non-uniformity of Moisture Content Fluctuations in Soil Foundations of High Volumetric Change, by H. C. Porter (pp. 256-260); Progress Report on an Investigation of Frost Action in Soils, by A. Mackintosh (pp. 260-262); Soil Consolidation Works Effected Near Elne, France, on a Bridge Over the Tech River, by P. Bachy (p. 263); Principles Governing Interpretation of Results Obtained Through Exploration of Soils for Foundation Purposes, by J. M. Abeleff (pp. 280-282); About the Protection of Structures from the Existence of Radiating Elastic Waves in the Soil, by D. D. Barkham (pp. 283, 284); Field Investigations of the Theory of Vibration of Massive Foundation Under Machines, by D. D. Barkam (pp. 285-288); A Method of Determining the Rate of Deformation in Soil Mass by Means of Electricity, by G. I. Pokrowski (pp. 289-290); Consolidation of Marine Clay, O. K. Froehlich (pp. 290-294); Pretest Shoring of Retaining Wall, by H. T. Immerman (pp. 294-296); and Experiments With Models for Determining the Deformation and Tensions in Foundations on Plastic Ground, by A. Pogany (pp. 298, 299).

No mention is made in this voluminous report of the work in soil dynamics which has been conducted at several of the state agricultural experiment stations.

INSTRUCTIONS FOR THE CONSTRUCTION AND INSTALLATION OF THE PARSHALL MEASURING FLUME AND BRISTOL WATER STAGE RECORDER. U. S. Dept. Agr., Soil Conserv. Serv., [1936], SCS-TP-6, pp. 7, pls. 3. The text of these instructions is presented, together with bills of material for the equipment and working drawings.

(Continued on page 334)



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Agricultural Engineering Digest

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THE COMMON STORAGE: ITS CONSTRUCTION AND MANAGEMENT, *D. Comin.* Ohio Sta. Bul. 573 (1936), pp. 49, figs. 15. This bulletin discusses the principles of construction and management of air-cooled storages, as well as materials for insulation, on the basis of results with an experimental storage and with commercial storages over the state. The discussion relates particularly to factors affecting the quality of stored fruit, the principles of common storage, and engineering factors involved in the construction, insulation, and ventilation of the storage. A section also is included on the remodeling of farm structures for storage purposes.

INSTRUCTIONS FOR THE CONSTRUCTION AND INSTALLATION OF THE RAMSER SILT SAMPLER. U. S. Dept. Agr., Soil Conserv. Serv., [1936], SCS-TP-5, pp. 8, pls. 9. The text of these instructions is presented under three parts. Part 1 relates to the silt box, part 2 to the divisor box and storage tank, and part 3 to the drainage of soil surrounding the equipment. Bills of material for the equipment are included, together with working drawings.

SOIL CONSERVATION AND FLOOD CONTROL, *H. H. Bennett.* U. S. Dept. Agr., Soil Conserv. Serv., 1936, SCS-MP-11, pp. 14. This is an address presented before the Connecticut Engineering Congress. It discusses in general the problem of soil conservation and flood control.

A HOMEMADE CENTRIFUGAL PUMP AND OTHER WATER-LIFTING DEVICES, *O. W. Monson and H. E. Murdock.* Montana Sta. Bul. 324 (1936), pp. 51, figs. 21. This bulletin describes equipment for low lifts in pumping water for irrigation where the allowable cost is limited. Several devices are described, but particular attention is given to the homemade centrifugal pump. This pump can be built in a wide range of sizes and has a large capacity at low lifts. A discharge of over 6 cu ft per second, or 2,700 gal per minute, was obtained with a 14-in pump at a lift of 8.5 ft in a test made at the station. The pump can be operated with an electric motor, a farm tractor, or a stationary gas engine. Under average conditions the power consumption will be about 0.35 hp per second-foot per foot lift. The cost of construction is low. The materials for a pump capable of delivering 5 cu ft per second at a lift of 10 ft should not cost more than $30 or $40.

DETERMINING THE TONNAGE OF HAY IN LONG STACKS AND ROUND STACKS, *F. B. Headley.* Nevada Sta. Bul. 143 (1936), pp. 14, figs. 7. Mechanical and graphic data are presented on the subject, based on Nevada conditions.

DIMENSION-STOCK METHODS FOR NEW ENGLAND HARDWOODS, *A. O. Benson.* U. S. Dept. Agr. Circ., 394 (1936), pp. 61, figs. 42. This circular presents information on equipping and operating a dimension-stock mill, its purpose being to simplify the problems confronting a prospective operator or one contemplating changes in an established plant. The mill planned is a composite of a large number of plants employing a wide variety of machines, layouts, and operating methods. The machines suggested are those which have given proof that they are particularly well adapted to a plant of this type.

USING WATER IN TRACTOR TIRES TO INCREASE DRAWBAR PULL. Impl. and Tractor, 51 (1936), No. 20, p. 30. The results of investigations are reported which indicate that the use of water within tractor tires has been found entirely satisfactory for additional weight requirements in field service. In describing the equipment required to induce water under pressure, it is pointed out that water under 50 lb pressure will flow through the connections and the valve stem at the rate of about 20 lb per minute. It is pointed out further that the use of water-filled tires in temperatures low enough to cause the formation of hard ice necessitates the use of antifreeze solutions.

ROCK WOOL IN RELATION TO HEALTH, *L. T. Fairhall, S. H. Webster, and G. A. Bennett.* Jour. Indus. Hyg., 17 (1935), No. 6, pp. 263-275, figs. 5. Studies conducted at Harvard University are reported, results of which indicate that no hygienic hazard exists in contact with commercial rock wool used for insulating purposes. The histological examination of the lungs, liver, and kidneys of experimental animals revealed no constant or significant pathological changes. In cats exposed to the dust from rock wool there was evidence of inhalation of considerable quantities of silicate, and the accompanying changes in the lungs were those which one might expect such foreign matter to produce.

RULES FOR THE AERATION OF SILOS [trans. title], *M. R. Legendre.* Genie Rural & Elect. Rurale, 29 (1936), Sept., p. 30, figs. 1. In this contribution the term silo is used to indicate a grain storage. On that basis graphic data are presented indicating the proper ventilation of grain storages for different conditions of humidity and conditions of grain in France.

EFFECT OF TETRAETHYL LEAD ON PREFLAME REACTIONS IN AN ENGINE, *L. Withrow and G. M. Rassweiler.* Indus. and Engin. Chem., Indus. Ed., 27 (1935), No. 8, pp. 872-879, figs. 6. Studies conducted by the General Motors Research Division are reported. Absorption spectra of the gaseous charge in an engine indicate that when tetraethyl lead is added to the fuel to prevent knock there is an effect on the preflame reactions in that portion of the charge which, in the absence of tetraethyl lead, suddenly inflames at the time of knock. Atomic lead has been identified in the noninflamed charge in the knocking zone at the moment that antiknock action is being effected, but no accompanying absorption by lead monoxide has been observed. When lead is vaporized in a hot nichrome tube the absorption spectra exhibit lead monoxide bands at lower temperatures than atomic lead lines. Comparison of experiments in and out of the engine indicate that lead monoxide is being reduced in the noninflamed charge.

SOIL EROSION AND ITS CONTROL, *Q. C. Ayres.* New York and London: McGraw-Hill Book Co., 1936, pp. XI+365, figs. 244. This is a general treatise on the subject of erosion control in which an attempt is made to bring together under one cover a general introduction to and correlation of all phases of the problem with the quantitative application of such data as are known at present. The author points out that the apparent disproportionate emphasis accorded to engineering phases of erosion control is partly attributable to the fact that more information of a practical and time-tested nature is available from that standpoint. Chapters are included on factors affecting rate of erosion, methods of control, rainfall and run off, terrace design, terrace location—principles and practice, terrace construction methods and machinery, terrace construction costs and maintenance, terrace outlets, control of gullies, temporary and semi-permanent check dams, permanent or soil-saving dams, special uses of vegetation, and soil conservation and land use. An appendix deals with simple methods of calculating land areas, partial list of soil conserving and depleting crops, partial list of plants favorable to soil conservation and wild life, two-thirds powers of numbers, and square roots of decimal numbers.

CHOPPING AND STORING ALFALFA HAY, *T. E. Hienton and J. H. Hilton.* Indiana Sta. Circ. 221 (1936), pp. 4, figs. 2. Practical information is presented on the subject.

MODERN DRYING MACHINERY, *T. J. Horgan.* Jour. Soc. Chem. Indus., Chem. and Indus., 54 (1935), No. 42, pp. 913-924, figs. 11. This is a technical description of modern drying methods and equipment.

(Continued on page 336)

Books Received

AIR CONDITIONING IN THE HOME, *by Elmer Torok.* First edition, cloth bound, 6x9 in, 296 pages, 50 illustrations, 39 tables, indexed. Industrial Press, New York, $3.00. This book is published as a reference for engineers, architects, and home owners. It covers what air conditioning does for the home, the functions of an air conditioning system, air conditioning equipment, air conditioning systems, installation and operation, principles of air conditioning, psychrometric tables for air conditioning calculations, examples illustrating use of psychrometric tables, heating calculations, cooling calculations, design of air distribution system, notes on equipment selection, standard code and a table of conversion factors.

DEGREE-DAY HANDBOOK, by Clifford Strock and C. H. B. Hotchkiss. Semi-flexible binding, 6x9 in, 298 pages, 29 tables, 27 illustrations, indexed. The Industrial Press, New York, $3.00. A revised and enlarged second edition for operating and designing engineers' use in checking heating plant operation and predicting fuel consumption. Its contents include temperature terms used by the Weather Bureau, symbols used in formulas, what the degree-day is, degree-day and other reference tables, how to use degree-day tables, degree-day tables, heating values of fuels, fuel required per degree-day, design temperatures and heating season data, heat carrying capacities of ducts, efficiency of fuels, degree-day as a guide to operating efficiency, degree-day in sales promotion, using the degree-day in market research, how the base temperature is established, use of degree-day in predicting fuel consumption, and data used in calculating summer cooling loads.

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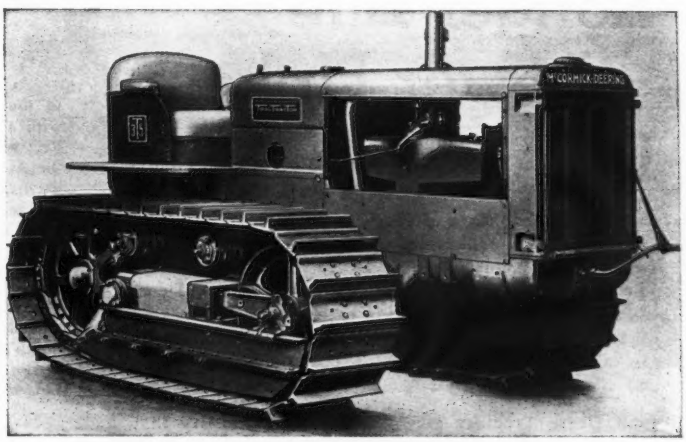

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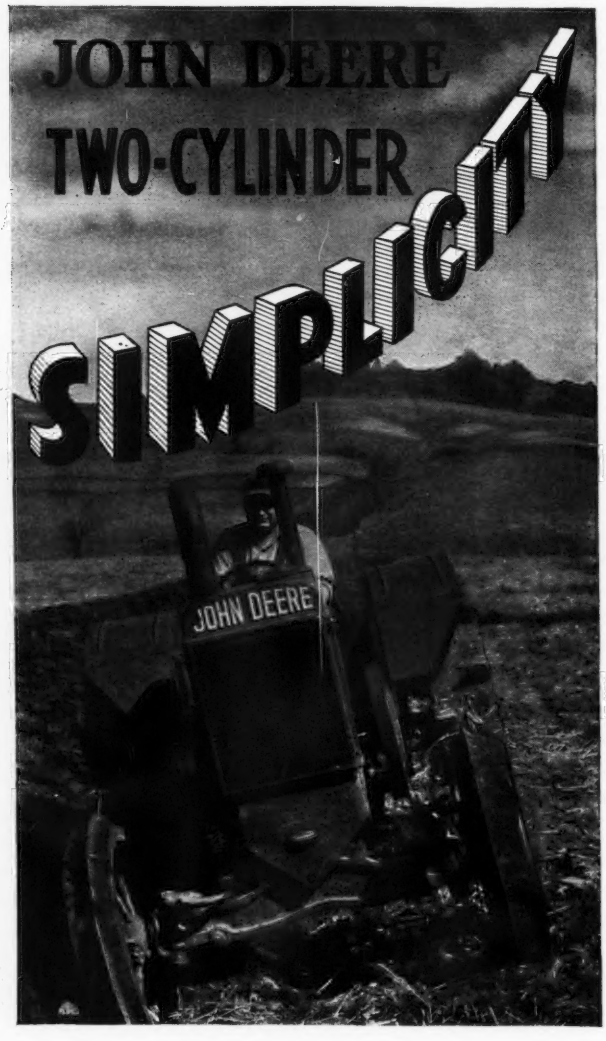

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Agricultural Engineering Digest

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GRASS DRYING. Rural Electrif. and Electro-Farming, 12 (1936), No. 137, pp. 92-94, figs. 2. A process of hay drying, and the corresponding equipment are described and details of cost involved presented, which is in use in England. The drier is arranged so that grass may be dried in two successive stages by a current of hot air drawn upward through 24-in beds of grass by means of an electrically driven fan. The grass is laid on trays which are placed side by side in drying chambers connected by air passages. The grass is held in position by weighted steel hurdles. During a 25-min cycle, one tray of grass is partly dried, and the other tray of grass, which has been previously partly dried, is completely dried. At the same time another pair of trays is made ready outside the drying chamber, so that, except for short intervals when the trays are exchanged, drying is continuous. When drying is complete, as shown by a thermometer, the trays are removed. The dried grass is transferred to the baler and a fresh charge of grass is prepared. Coke or anthracite coal is burned in a steel chamber lined with firebrick to provide the necessary hot air for drying.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

DESIGNERS and layout men familiar with grain, hay, and corn harvesting machinery wanted by a leading manufacturer of farm equipment. Must be high-grade men. PO - 115.

DESIGNING ENGINEER wanted by a farm implement manufacturer. Experience with plows, seeders, and general tillage tools is essential. Apply in care of ASAE, St. Joseph, Mich. PO-116.

JUNIOR AGRICULTURAL ENGINEER. The U. S. Civil Service Commission announces an assembled open competitive examination for the position of junior agricultural engineer. Applications must be on file with the Commission at Washington, D. C., not later than July 26, or July 29 for those mailed from several states in the far west. Application form 8, copies of which may be obtained at any first-class postoffice, should be used in filing application for this examination. In the examination 50 per cent of the weight will be placed on engineering fundamentals and 50 per cent on agricultural engineering. More detailed information is given in the Commission's announcement No. 54.

POSITIONS WANTED

AGRICULTURAL ENGINEER desires employment preferably in the educational field. Graduate of Clemson College (1936) with a bachelor of science degree, agricultural engineering major. Received master of science degree in agricultural engineering from the A. & M. College of Texas in June 1937. In college work he has had 1½ years of teaching experience while serving as graduate assistant in the agricultural engineering department at the A. & M. College of Texas. Served as assistant extension agricultural engineer with the South Carolina Extension Service during the summer of 1936. Now employed. PW-275.

AGRICULTURAL ENGINEER, graduate of midwestern state college from four-year course in agricultural engineering, six month's experience as materials inspector with state highway commission, one year's experience in soil classification and mapping, some experience in soil conservation engineering, desires a change to a broader field of service, irrigation or research preferred. Married. PW-277.

AGRICULTURAL ENGINEER, graduate of University of Wisconsin, with master's degree in agricultural engineering from an eastern school, desires employment where past experience will be of value in future work. Has farm background, five year's experience in college teaching of agricultural engineering, three years with U. S. Department of Agriculture, two of which were in the Soil Conservation Service. Past experience mainly with machinery and erosion control practices. Age 33. Married. PW-278.